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September 4, 2014

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Mr. Eric Veerkamp, CPM
California Energy Commission
1516 Ninth Street
Sacramento, CA 95814

Subject: Colusa Generating Station (06-AFC-09C)
Condition of Certification Soil & Water-2
Revised Drainage Erosion Sedimentation Control Plan

Dear Mr. Veerkamp:

On behalf of Pacific Gas and Electric Company (PG&E), CH2M HILL is submitting a revised Drainage Erosion and Sedimentation Control Plan (DESCP) for the Colusa Generating Station (06-AFC-09C). The revised DESCP fulfills the requirements of Condition of Certification Soil & Water-2 and addresses measures necessary to protect water and soil resources during the construction of the 0.86-mile back-up water supply pipeline authorized under the Staff Approved Project Modification (Transaction Number 202974).

If you have any questions, please call Mr. Charles Price at 530-934-9007.

Sincerely,

CH2M HILL

Jerry Salamy
Principal Project Manager

Drainage, Erosion, and Sedimentation Control Plan for the Colusa Generating Station Project

Prepared for

Pacific Gas and Electric Company

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Drainage, Erosion, and Sedimentation Control Plan for the Colusa Generating Station Project

Submitted to

Pacific Gas and Electric Company

September 2014

CH2MHILL

Contents

Appendix

Colusa Generating Station Project Drainage, Erosion, and Sedimentation Control Plan

Pacific Gas and Electric Company (PG&E) is currently developing and constructing the Colusa Generating Station (CGS) project. The CGS will be a 600-megawatt natural gas-fired, dry cooled, combined-cycle electrical generating facility. The CGS generating facility and its associated liner features will be owned by PG&E.

PG&E has prepared this Drainage, Erosion and Sedimentation Control Plan (DESCP) for the CGS project to demonstrate that construction activities associated with the project will not result in an increase in off-site flooding potential or sedimentation and that the project will meet all local, state, and federal regulatory requirements associated with the protection of water quality and soil resources. The DESCP includes the following elements:

- A vicinity map showing the location of all project elements with depictions of all significant geographic features including swales, storm drains, and sensitive areas
- A site delineation that includes the boundary lines of all construction areas and the location of existing and proposed structures, pipelines, roads, and drainage facilities
- Topographic site maps showing water courses, critical areas, and existing/proposed drainage systems
- A description of the drainage measures to be taken to protect the site and downstream facilities, including a discussion of compliance with the Regional Water Quality Control Board (RWQCB) discharge order
- A delineation of all areas to be cleared of vegetation and areas to be preserved
- Identification of the quantities of material excavated or filled for the site and all project elements, including those materials removed from the site due to contamination
- An illustration of existing topography and site-specific Best Management Practices (BMPs) to be implemented during construction, as well as a schedule of the timing and implementation of erosion and sediment control measures
- Erosion control drawings and erosion and sedimentation control notes

A. Vicinity Map

Figure 1 shows a vicinity map of the project site and surrounding area (all figures are provided at the end of this document). The CGS project site consists of 100 acres of a 451-acre parcel (Assessor's Parcel Number 11-040-024, Colusa County) and is located in an unincorporated portion of Colusa County, located in the western Sacramento Valley. The CGS project site is situated approximately 4 miles to the west of Interstate 5, 6 miles northwest of the farming community of Maxwell, 14 miles north of the farming community of Williams, and 72 miles north of Sacramento. The CGS project site is found within the eastern half of Section 35, Township 18 North, Range 4 West, Mount Diablo Base and Meridian. The 100-acre CGS project site will be leased by PG&E from the Holthouse Ranch.

B. Site Delineation

Figures 2a and 2b shows a detailed site plan of the CGS project and back-up water supply pipeline. The project site area will contain the power station equipment, access roads, adjacent corridor connections to existing transmission lines, utilities including gas line connections, and other associated features. A 20-foot-wide paved road, Noel Evans Road, accessed from Dirks Road, provides access to the existing PG&E Delevan Compressor Station. Access to the power plant site will be provided by a new 30-foot-wide, 2,500-foot-long extension of the existing access road and PG&E Road Easement.

Figures 3a-e show a detailed view of the areas expected to be disturbed during construction. During construction, the project will use about 43 acres for temporary construction offices, construction parking, and construction equipment and material lay down; these areas will be located north, west and east of the power plant. The replacement of the Teresa Creek Bridge on McDermott Road will result in temporary disturbance of approximately 6 acres and permanent disturbance of approximately 0.36 acre of irrigated agricultural land currently used to grow rice and wheat or row crops. The replacement of the Teresa Creek Bridge is necessary to accommodate the heavier construction loads associated with the project. Replacement of the Teresa Creek Bridge will entail one of two options. One option would be to install a temporary bridge to the east of the existing bridge prior to replacement of Teresa Creek Bridge that would be a clear span bridge or a prefabricated bridge. The second option would be to detour traffic using McDermott Road to an alternate route during construction of the new bridge. The new bridge would either be a clear span bridge or a prefabricated bridge. The plan for the bridge type selected is dependent upon the project schedule and has yet to be determined. Once the design is finalized and prior to any soil disturbance, the owner will update this DESCP and the SWPPP.

Similarly, the Glenn-Colusa Canal Bridge located on Dirks Road west of I-5 cannot currently accommodate heavy construction or two-way truck traffic and will be replaced. The new bridge will be a three-span steel beam and concrete structure approximately 100 feet long by 30 feet wide. This bridge design would provide two 12-foot lanes with 3-foot shoulders giving unimpeded two-way traffic flow. Two rows of five piers will be constructed in the canal to support the bridge and oriented to reduce impeding the flow of water and to minimize the collection of debris. The east approach will be located 75 feet south of the existing bridge and the west approach will be located 45 feet south of the existing bridge. This new bridge would be capable of handling the heaviest loads required for the construction and operation or the power plant. The existing bridge would remain during the new bridge construction and then be removed after the new bridge construction is completed. Removal of the existing bridge piers will offset the potential impacts of the new bridge piers on the flow of water.

Water for construction and operation needs will be provided by the Glen-Colusa Irrigation District. The water supply intake will be at the Tehama-Colusa Canal. Access to the intake will be provided by a new bladed 12-foot-wide, 2,700-foot-long unpaved road situated between the power plant site and the canal, along the water pipeline alignment.

Furthermore, a new 0.86-mile 6-inch diameter back-up water supply pipeline will be constructed to transport Glen-Colusa Irrigation District water from Glenn-Colusa Canal to the Colusa Generating Station. PG&E would access the water from an existing pump station, located immediately north of Dirks Road, which is owned and operated by the farmer whose field borders the canal. A new pump and electrical panel would be installed in a disturbed area adjacent to the existing pump station to draw water from the existing pump station's intake basin to the new water pipeline (see Figures 2a & 2b). Approximately 0.93 acres will be disturbed as a result of construction of the new waterline. The project will employ a zero-liquid discharge system which will result in no process wastewater being discharged from the plant. In addition, a new 8-inch, 1,500-foot pipeline from PG&E's Delevan Compressor Station will provide the required natural gas to fuel the facility. Approximately 3.6 acres will be disturbed as a result of construction of the new natural gas and water pipelines. A new 2,500 paved access road linking PG&E's Delevan Compressor Station to the facility will also be constructed.

Four new double circuit lines (each approximately 2,000 feet) will connect the CGS switchyard with the existing 230 kV PG&E transmission lines that run parallel to the Glenn-Colusa Canal along the eastern boundary of the project site. The transmission interconnection will require approximately 12 new towers and 48 new tower footings. Four of the towers (16 footings) will be within the project site; eight of the towers (32 footings) are estimated to be outside of the 100-acre plant site property. The new transmission line structures will be approximately 100 to 125 feet in height. Four existing towers will need to be refitted and two towers will be removed. The final configuration will be determined and approved by PG&E.

The project area will be fenced with a 6-foot high galvanized chain link fence, supported on galvanized poles on drilled and cast footings, with a sliding electric gate at its main entrance. Additional double leaf gates will be incorporated as required for emergency access and egress.

The location and properties of the soil mapping units were identified from draft maps of the area using an aerial photograph base and from preliminary drafts of soil property descriptions, both prepared by the Natural Resources Conservation Service. The Soil Survey of Colusa County has not yet been published in hard copy form. Of the 17 soil mapping units in the vicinity of the proposed CGS site, only 7 will potentially be affected by the construction of the power plant. The following paragraphs provide a brief description of the seven soil types potentially affected by CGS construction.

In addition to the soils information provided below, the U.S. Department of Agriculture Soil Survey for Colusa County, California (Natural Resources Conservation Service, 2006) indicates that surface soils at the site consist chiefly of clays, silty clays, and clayey loams, almost entirely classified as hydrologic group D soils series, which are described by the USDA as, "soils having a very slow infiltration rate (high runoff potential) when thoroughly wet."

Al – Alcapay Clay, 0 to 1 Percent Slopes

This nearly level soil is somewhat poorly drained and makes up basins within the site area. The representative profile is 64 inches. The permeability is slow and the soil exhibits high shrink potential upon drying. Major land use includes irrigated crops. Vegetation includes rice. Surface runoff is negligible to low and there is a slight hazard of water erosion in bare areas.

AaA – Altamont Clay, 5 to 9 Percent Slopes

This soil, which appears in foothills, has medium to high runoff, is well drained, and has high shrink-swell potential. The representative profile is 60 inches, and the permeability is slow. Most areas of this unit are used for livestock grazing. Vegetation includes soft chess, wild oats, annual grasses, and forbs, with scattered blue oak in some areas. Hazard of water erosion in bare areas is moderate. Approximately 60 percent of the plant area is underlain by this soil unit.

AyA – Ayar Clay, 5 to 15 Percent Slopes

This sloped soil is well drained and makes up foothills within the site area. The representative profile is 72 inches. The permeability is slow and the soil exhibits high shrink potential upon drying. Major land use includes livestock grazing. Vegetation includes soft chess and wild oats. Surface runoff is medium to high and there is a moderate hazard of water erosion in bare areas.

CaA – Capay Clay Loam, 0 to 1 Percent Slopes, Occasionally Flooded

This nearly level soil is moderately well drained and makes up basins within the site area. The representative profile is 64 inches. The permeability is slow and the soil exhibits high shrink potential upon drying. Major land use includes livestock grazing. Vegetation includes soft chess, wild oats, and star thistle. Surface runoff is negligible to low and there is a slight hazard of water erosion in bare areas. Approximately 40 percent of the plant area is underlain by this soil.

CaB – Capay Clay Loam, 0 to 3 Percent Slopes

This nearly level soil is moderately well drained and makes up basins within the site area. The representative profile is 33 to 64 inches. The permeability is slow and the soil exhibits high shrink potential upon drying. Major land uses include livestock grazing and home site development. Vegetation includes soft chess, wild oats, and star thistle. Surface runoff is negligible to medium and there is a slight hazard of water erosion in bare areas.

Cc – Clear Lake Clay, 0 to 2 Percent Slopes, Occasionally Flooded

This nearly level soil is poorly drained and makes up basins within the site area. The representative profile is 80 inches. The permeability is slow and the soil exhibits high shrink potential upon drying. Major land use includes livestock grazing. Vegetation includes soft chess, wild oats, and star thistle. Surface runoff is negligible to medium and there is a slight hazard of water erosion in bare areas.

Hl – Hillgate Loam, 0 to 2 Percent Slopes

This nearly level soil is well drained and makes up terraces in the site area. The representative profile is greater than 60 inches. The permeability is slow and the soil exhibits high shrink potential upon drying. Major land uses include irrigated cropland, non-irrigated cropland, and livestock grazing. Commonly grown crops are almonds and walnuts.

Vegetation on grazing areas includes soft chess, wild oats, ripgut brome, filaree, and other annual grasses and forbs. Surface runoff is negligible to low and there is a slight hazard of water erosion in bare areas.

Hcl – Hillgate Clay Loam, 0 to 2 Percent Slopes

This nearly level soil is well drained and makes up terraces in the site area. The representative profile is greater than 73 inches. The permeability is slow and the soil exhibits high shrink potential upon drying. Major land use includes irrigated cropland. Commonly grown crops are rice, corn, tomatoes, beans, and winter grains. Surface runoff is negligible to low and there is a slight hazard of water erosion in bare areas.

C. Watercourses and Critical Areas

The CGS project site is located 6.5 miles north, northwest of Maxwell, California, at an altitude of 197 - 210 feet (above mean-sea-level). Most of the precipitation in the project area falls during January through March and July through September. The rainfall for a 100-year 24-hour event is 3.3 inches and 2.8 inches for a 6-hour event; a 10-year 24-hour event is 1.9 inches and 1.6 inches for a 6-hour event (NOAA Atlas 2). Colusa Valley is a semi-arid, topographically closed basin. The average annual precipitation at the project site from 1971 to 2000 was 8.31 inches.

The CGS project site is located within the Hunters Creek watershed. Hunters Creek drains east to the Colusa Drain/Trough and south to canals eventually discharging into the Sacramento River. The project area includes vernal pools, vernal pool grasslands, seasonal wetlands, freshwater marsh, and cultivated rice fields, some of which have been verified as waters of the United States (Figure 4). Any project grading and filling activities that result in direct disturbance of these water features will require a permit under Section 404 of the Clean Water Act.

The CGS project site is located approximately halfway between Tehama-Colusa and Glenn-Colusa canals. Drainage is generally from west to east, perpendicular to the alignment of the canals. The CGS plant will be located on cut and fill in local high ground between the canals. Runoff collecting as shallow concentrated flow coming towards the site from the west will be intercepted by diversion ditches and directed around the site during construction and for post development conditions. For the final developed condition, runoff collected on built up areas of the site will be detained in storm water management ponds with discharge maintained equal to or less than predevelopment peak levels as calculated with standard hydrologic methods. The discharge from all storm water management ponds will outfall onto riprap aprons, or level spreaders, designed to avoid erosion and reduce the velocity of the flow before reaching existing swales.

Surface water impacts, if any, are anticipated to be a by-product of short-term construction activity and consist of increased turbidity due to erosion of newly excavated or placed soils. Activities such as grading can potentially increase rates of erosion during construction. In addition, construction materials could contaminate runoff or groundwater if not properly stored and used. Compliance with engineering and construction specifications, following approved grading and drainage plans, and adhering to proper material handling procedures will ensure effective mitigation of these short-term impacts. The CGS construction activity does not discharge directly to a water body listed as impaired for sedimentation/siltation or turbidity under the Clean Water Act Section 303(d).

D. Drainage Map

Figures 5a-c show all existing, interim, and proposed drainage systems and drainage area boundaries.

E. Drainage Narrative

Based on preliminary feasibility studies, it was estimated that approximately 89 acres of the 100-acre fenced lot would be disturbed at some time during construction. A large percentage of the disturbed area will be regraded and returned to a vegetated state after construction, including areas disturbed by construction of the back-up waterline.

The stormwater management system was designed in accordance with the EPA's guidance document entitled "Storm Water Management for Construction Activities—Developing Pollution Prevention Plans And Best Management Practices" (EPA 832-R-92-005, September 1992), the California Storm Water Best Management Practices Handbook, and the Central Valley Regional Water Quality Control Board Order No. R2-2003-002.

Under the National Pollutant Discharge Elimination System (NPDES) *General Permits for Storm Water Discharges from Construction Sites,* it is necessary to estimate the runoff coefficient of the site before and after construction is complete. A hydraulic analysis was prepared and stamped by a Professional Engineer, and is included as Appendix A.

Relevant attachments to the hydraulic analysis include:

- Runoff Calculations – Power Block
- Runoff Calculations – Land Pre-development
- Runoff Calculations – Land Post-development
- Catch Basin, Manhole, and Pipe Schedule
- StormCAD Calculation Results Summary
- Swale Calculations
- Weir Calculations
- Standard 600-10C Grate
- North Basin Calculations
- South Basin Calculations
- West Basin Calculations
- Permissible Velocities for Earth-lined Channels

A summary of the project site hydraulic analysis is presented in Table 1.

TABLE 1
Summary of the Hydraulic Analysis

Construction site area	116 acres
Percentage impervious area before construction	70 %
Runoff coefficient before construction	0.44

TABLE 1
Summary of the Hydraulic Analysis

Percentage impervious area after construction	80 %
Runoff coefficient after construction	0.85
Anticipated stormwater run-on for 10-year 6-hour storm	81.66 cubic feet per second

Stormwater runoff at the site is predominantly sheet flow from west to east, eventually discharging into the local irrigation canals. With exception of the power block area (the area where the primary power generation equipment is located), site development will maintain sheet flow where possible, with water exiting the site in existing natural contours and flows.

To protect the power block and tower areas from floods, a western diversion ditch will be provided to channel storm runoff around each area before discharging as sheet flow. The power block area will be graded with moderate slopes to direct runoff and diverted stormwater to a sedimentation basin, which will be converted to a permanent detention basin, before overflowing through native stone rip-rap to reinstate natural sheet flow conditions. Relatively small rock filters and local diversion berms through the sites will discourage water from concentrating to maintain sheet flow. The diversion ditches and sedimentation basins were designed to accommodate the peak runoff from the 10-year, 24-hour storm event to prevent damage to the power block and tower areas, and empty discharge after 48 hours or less allowing sediments and onsite pollutants to settle. The site drainage system will be designed to pass a 50-year storm event without flooding the roads and the main plant. Table 2 provides a summary of the design criteria for the diversion ditches and sediment basins based on the hydraulic analysis provided as Appendix A.

TABLE 2
Design Criteria Summary for Diversion Ditches and Sediment Basins

Diversion Ditches	Design Criteria
Drainage area	No more than 5 acres
Swale bottom width	At least 2 feet
Swale depth	At least 12 inches
Side slope	2:1 (H:V) or flatter
Storm swale	10-year storm event
Sediment Basin	**Design Criteria**
North Basin	
Bottom dimensions	460 feet x 150 feet x 5 feet deep
Side slope	3:1 (H:V)
Total required volume	310,731 cubic feet
Dead settlement volume	81,785 cubic feet
Live water volume	232,654 cubic feet

TABLE 2
Design Criteria Summary for Diversion Ditches and Sediment Basins

Diversion Ditches	Design Criteria
Basin capacity	314,359 cubic feet
Required orifice diameter	8.5 inches
Outlet pipe (corrugate metal pipe)	30 inches
Velocity after energy dissipated	2.36 feet per second
South Basin	
Bottom dimensions	250 feet x 100 feet x 4.25 feet deep
Side slope	3:1 (H:V)
Total required volume	80,657 cubic feet
Dead settlement volume	26,061 cubic feet
Live water volume	66,678 cubic feet
Basin capacity	92,712 cubic feet
Required orifice diameter	5.25 inches
Outlet pipe (corrugate metal pipe)	30 inches
Velocity after energy dissipated	2.23 feet per second
West Basin	
Bottom dimensions	310 feet x 100 feet x 5 feet deep
Side slope	3:1 (H:V)
Total required volume	127,712 cubic feet
Dead settlement volume	32,240 cubic feet
Live water volume	112,158 cubic feet
Basin capacity	144,330 cubic feet
Required orifice diameter	5.75 inches
Outlet pipe (reinforced concrete pipe)	30 inches
Velocity after energy dissipated	2.48 feet per second
Design volume for detention purpose per 10-year storm event	11,813 cubic feet
Inlet pipe (smooth lined polyethylene pipe)	36 inches
Velocity after energy dissipated	2.78 feet per second

The areas of the watersheds used in the calculation of the diversion ditches and three sedimentation basins are shown in Figures 6 and 7. These drainage areas were used in the runoff calculations for the power block area (16.6 acres), land pre-development area (100 acres), and land post-development area (77.4 acres). The power block, land pre-development, and land post-development runoff calculations are available in Attachments 9, 10, and 11, respectively, of Appendix A.

The runoff calculations used to support the selection and sizing of the diversion ditches, sedimentation basins, and structural controls that will be employed to divert offsite drainage were based on the Rational Method and Intensity Duration Frequency Curves for Colusa County. The Rational Method provides specific guidelines to estimate the peak runoff flows on the power block, land pre-development, and land post-development. The Rational Method is expressed by equations and tables using the known runoff coefficient, average rainfall intensity, and drainage area. Average rainfall intensity of each storm event can be obtained from the Intensity Duration Frequency Curves for Colusa County from 1940 to 1974, with known time of concentration. The Rational Method calculation tables and Intensity Duration Frequency Curves for Colusa County are provided in Attachments 2 and 3, respectively, of Appendix A.

Haestad Methods' FlowMaster was used to design spillway weirs, drainage swales, and sediment basin outlet pipes. Haestad Methods' StormCAD was used to design the stormwater drainage system in the power block area. Pipe flow rate is calculated using StormCAD software, which accounts for the total area and runoff that is contributing to each pipe and inlet. The calculation summary from StormCAD for the power block area is presented in Attachment 13 of Appendix A. The minimum full-flow velocity for the power block's stormwater drainage system is approximately 2.69 feet per second and the maximum full-flow velocity is approximately 12.61 feet per second, both of which meet the required minimum (2 feet per second) and maximum (15 feet per second) flows.

Paved access roads will be protected from floods via ditches, culverts and local fords with reinforced concrete shoulders. Overall the project is being designed to maintain, to the extent possible, the existing sheet flow patterns on the site.

The following drainage, erosion, and sediment control methods and practices will be implemented at the CGS project site as necessary. A Best Management Practice (BMP) Map showing the locations of all BMPs for all project components (project site, bridge replacement site, linear construction areas, new back-up water supply line, and project laydown area) will be completed prior to construction and included in this report and in the SWPPP. The BMP map will be updated as construction conditions on-site change throughout the construction period.

Silt Fence Protection. A silt fence is to be installed around the perimeter of the entire project site and within other construction areas, including bridge replacement and road modification sites, construction lay down areas, and on either side of all linear excavations advance on and off site. In addition to the perimeter silt fence, straw wattle dikes shall also be installed around the construction lay down and parking areas and within drainage channels with a slope greater than 1 percent. Where possible the silt fence and straw bale dikes are to be installed parallel to the ground contours to avoid concentration of flow at low points.

The bridge replacement sites may require the placement of silt fencing, coir logs, coir rolls, straw bale dikes, or other siltation barriers so that silt and other deleterious materials are not allowed to pass to downstream reaches. Passage of sediment beyond the sediment barriers is prohibited. PG&E is responsible for the removal of non-biodegradable silt barriers, such as plastic silt fencing, after the disturbed areas have been stabilized with erosion control vegetation. Any temporary dam or other artificial obstruction constructed shall only be built from clean materials such as sandbags, gravel bags, water dams, or clean/washed gravel that will cause little or no siltation and will require permission from the appropriate regulatory agencies.

Stabilization Practices. Disturbed areas will be provided with permanent vegetative cover. Seeding operations will take place after slopes and other areas have received final grading. Vegetative stabilization shall occur as soon as possible after disturbance has permanently or temporarily ceased, but in no case more than 14 days after the construction activity in an area has ceased. An exception to this requirement is for when construction activity will resume on that portion of the site within 21 days.

A range of seedbed preparation methods shall be used. The seedbed preparation method used for any individual site shall depend on various factors including size of the area, slope, potential for erosion, and landowner requirements. The seedbed shall be prepared to a depth of 3 to 4 inches, where possible, by harrowing, disking, or mechanical raking. Seed shall be dispersed by dry broadcasting where slopes are less than 2:1. Manually operated cyclone type spreaders will be employed to uniformly broadcast the seed. After broadcasting, the seed shall be manually raked, on contour, into the top 3/8 inch of soil.

Vegetative Stabilization for Bridge Replacements and Water Intake

The extent of construction activities for bridge replacements will be limited to the minimum extent along the banks as possible. Vegetation disturbed during bridge replacements will be replanted with appropriate native species, such as California bulrush *(Scirpus californicus)*, cattail *(Typha spp.)*, and water primrose *(Ludwigia peploides)* in the emergent wetland area. Native erosion control seed mix including creeping wild-rye *(Leymus triticoides)*, meadow barley *(Hordeum brachyantherum)*, tomcat clover *(Trifolium willdenovii)*, annual fescue *(Vulpia spp.)*, blue wildrye *(Elymus glaucus)*, mugwort *(Artemisia vulgaris)*, and California brome *(Bromus carinatus)* would be applied to upland areas and areas adjacent to streams. Seeded areas shall be covered with broadcast straw and/or jut netted (monofilament erosion blankets are not authorized in the giant garter snake habitat adjacent to Teresa Creek). Vehicle traffic will be restricted from revegetated areas.

The banks will be restored as close to their original condition as possible once construction activities have been completed. The original bridge approaches would be graded to match the surrounding land contours and seeded with grass native to the region. New plantings will be monitored for one year until the banks are adequately revegetated to prevent erosion and sedimentation of these areas and the banks have similar total vegetation cover equal to or greater than adjacent areas. Additional plantings will be implemented if adequate vegetation cover is not attained after one year.

Vegetation disturbed during and after construction of the intake and associated pipeline at the Tehama-Colusa Canal will be replanted with native erosion control seed mix including creeping wild-rye, meadow barley, tomcat clover, annual fescue, blue wildrye, mugwort, and California brome. This seed mix would be applied to upland areas and areas adjacent to streams. Silt fences and erosion control blankets will be installed on all disturbed slopes greater than 2:1. Progress in reestablishing vegetation along the impacted reaches of the

Tehama-Colusa Canal, Glenn-Colusa Canal, and Teresa Creek will be monitored and reported to the USFWS one year after restoration is implemented.

Vegetation Stabilization for Upland Areas

Permanent erosion control for the construction lay down area and temporary access roads will consist of revegetation with a native erosion control seed mix equivalent to the following:

- Blando brome *(Bromus hordeacous)* at 30 pounds of pure live seed per acre,
- Zorro fescue *(Vulpia myuros)* at 6 pounds of pure live seed per acre, and
- Hykon rose clover *(Trifolium hirtum)* at 12 pounds of pure live seed per acre.

A qualified biologist or erosion control specialist will evaluate the upland revegetation using the following performance criteria:

- Year 1: 70 percent of vegetation cover measured at undisturbed reference sites adjacent to project site,
- Year 2: 80 percent of vegetation cover measured at undisturbed reference sites adjacent to project site,
- Year 3: 95 percent of vegetation cover measured at undisturbed reference sites adjacent to project area.

Erosion control will be considered successful if the following erosion thresholds are not exceeded:

- Flow Pattern Development – More than 25 percent of the area shows evidence of recent translocation and deposition of soil and litter.
- Rills – Usually greater than 3 inches deep and found at 10-foot intervals.
- Gullies – More frequent than 200-foot intervals and appear to be unstable.

If performance criteria for revegetation and erosion control are not met, remedial measures will be implemented. Areas that do not meet revegetation criteria will be reseeded. If necessary, the erosion control seed mix may be modified to substitute other native species to improve success. In addition, temporary erosion control measures including silt fences, erosion control blankets, bio-logs, or straw bales will be installed as necessary to prevent ongoing erosion or sedimentation until remedial seeding measures can be fully implemented. All erosion control measures will be monitored monthly during the wet season (approximately December 1 to April 1). Revegetation will be monitored each May for the first three years following project completion. Monitoring will be conducted by a USFWS-approved biologist.

Structural Practices. A sediment basin will be provided at the outlet of each of the four post-development drainage areas, for sediment control during construction. Each basin will be formed by the construction of an engineered earth embankment, with additional volume provided by excavation, as necessary. The basins will be designed in accordance with Best Management Practices published by the State of California.

Outlet works for the sediment control basins will include a vertical riser with a single orifice, attached to a horizontal outfall pipe placed under the embankment. The outfall pipe will convey inflow from the dewatering orifice to the outlet, which will be protected with riprap, or other similar materials, to prevent erosion. For those basins to remain in service, the outfall pipe will be sized for final development flows, for use in storm water management, or drainage.

A 20-foot wide emergency spillway structure will be excavated into existing ground for each basin to convey flow in excess of the basin storage and outlet works capacity. Following Best Management Practices (BMP) requirements, settling volume sufficient to hold the two-year runoff event will be contained between the bottom of the orifice and the emergency spillway. The orifices will be sized to dewater the pond in about 40 hours to eliminate the potential for mosquito breeding.

A riprap apron will be placed at the outlet from each sediment basin to protect the outfall channel from erosive velocities and permit spreading of the discharge from the pipe which will further slow the velocity of the discharge to non-erosive velocities. Upon completion of construction activities, the accumulated sediment in the basin will be removed along with the gravel berm and temporary sump structure. The sediment cleaned from the basin will be placed in the construction lay down area.

Once the storm drains and catch basins are installed, each catch basin shall be provided with inlet protection to reduce sediment accumulation in the storm drain system.

Construction Silt and Dust Control. During activities associated with project construction, control measures will be implemented to minimize the potential for impacts of erosion and sedimentation. With proper installation and maintenance of silt fence and the implementation of temporary and permanent soil stabilization procedures, the amount of silt leaving the site will be greatly reduced and/or eliminated. Fugitive dust may be generated during dry weather conditions. PG&E's Air Quality Construction Mitigation Manager will direct dust control activities and will comply with temporary arid permanent stabilization methods. Water sprinkling will be used for dust control.

Offsite Sediment Tracking. A tire wash station will be installed along the main access road to remove sediment from construction vehicles before leaving the site and entering public access roads. Site roads will be aggregate surfaced during the construction phase of the project to reduce offsite sediment tracking. Each site entrance/exit will be stabilized according to ESC 24 California Storm Water BMP Handbook.

Construction Dewatering. Storm water from construction excavation areas will be pumped and transferred directly via hose line into a sediment basin for settling of sediment prior to discharge to the storm water sedimentation basin. The RWQCB will be notified and a permit obtained prior to the discharge of any groundwater. The Contractor will be responsible for meeting the specific testing, monitoring, and discharge requirements set forth by the RWQCB.

Petroleum Products. Construction equipment will require use of diesel fuel and oil on a regular basis. While a potential exists for spills or leaks, all onsite vehicles will be monitored for leaks and receive regular preventive maintenance to ensure proper operation and reduce the chance of leakage. No "topping off' of fuel tanks will be allowed to further reduce the possibility of spills.

Petroleum products will be stored in clearly labeled and tightly sealed containers or tanks. Any asphalt used onsite will be applied according to the manufacturer's recommendations. Any soil impacted by fuel or oil spills will be removed and disposed of by the Contractor at an approved disposal site. Several oil filled transformers will be utilized for construction power and several additional oil filled transformers will be temporarily stored on-site. The transformers shall be provided with temporary secondary containment. All stormwater discharged for the temporary secondary containments shall be checked for any evidence of petroleum impacts (such as sheens or product) prior to release.

It will be the Contractor's responsibility to ensure that secondary containment around fuel/oil tanks (stationary or mobile) and oil filled transformers will meet the minimum requirements of the U.S. Environment Protection Agency (EPA) 40 CFR Part 112 with regard to secondary containment or more stringent state requirements, if applicable. Any spills will be contained and cleaned up immediately.

Sanitary Wastes. A licensed sanitary waste management contractor will collect all construction or temporary sanitary wastes from the portable units. The units will be maintained on a regular basis.

Hazardous Wastes. Potentially hazardous waste associated with construction of the project will be limited to small quantities of liquids and solids such as lubricating oils, acids for equipment cleanup, concrete curing compounds, and waste paint. These wastes are typical of industrial construction activities and will be placed in containers onsite and disposed in accordance with applicable LORS and with the manufacturer's recommendations. Hazardous wastes will be either recycled or disposed of in a licensed Class I disposal facility, as appropriate. Waste oil and used oil filters will be recycled if the maintenance activities will take place onsite. Waste generated during each chemical cleaning operation will be temporarily stored onsite in portable tanks and disposed offsite by the chemical cleaning contractor at an appropriate disposal facility. Site personnel will be instructed of these procedures and the Contractor's Site Manager will be responsible for implementing these practices.

To prevent contact of hazardous wastes with storm water runoff, secondary containment will be provided such as curbs and berms. As much as possible, all materials will be kept in a dry covered area.

Paints. All containers will be tightly sealed and properly stored to prevent leaks or spills. Excess paint will not be discharged to the storm water system. Unused paints will be disposed in labeled original containers according to applicable local, state, and federal laws and regulations. Spray painting will not occur on windy or rainy days, and a drop cloth will be used to collect and dispose of drips associated with painting activities. All paints will be mixed indoors, in a containment area. If using water based paints, equipment will be cleaned in a sink that is connected to the sanitary sewer.

Concrete Trucks. Concrete trucks will not be allowed to discharge surplus concrete and drum wash at the site, unless these materials are fully contained in an engineered structure that can contain all free liquid until dry. Dried concrete shall then be removed and disposed of at an off site location. Alternatively, concrete washout will be taken off-site for disposal by the concrete contractor. No surplus concrete or drum wash water will be disposed of onto the ground surface.

Waste Materials. All construction waste material, trash, and construction debris will be collected and stored in a metal dumpster, leased from a licensed solid waste management contractor. The dumpster will meet all local and state solid waste management regulations. The dumpster will be emptied a minimum of twice per week or more often if necessary, and the trash will be hauled to the local dump. No construction waste will be buried onsite. All site personnel will be instructed regarding the correct procedure for waste disposal. The Site Manager will be responsible for seeing that these procedures are followed. All dumpsters will be covered, where possible. At the bridge replacement sites, all cleared material shall be removed from the riparian/stream zone. Vegetation removal will be permitted only under the guidance of the regulatory agencies.

Allowable Non-Stormwater Discharges. The following sources of non-storm water discharges may be combined with storm water discharges from project construction activities:

- Pavement wash waters and dust control water not containing toxic or hazardous substances.
- Firefighting waters.
- Vegetation watering.
- Potable or spring water discharges.

F. Clearing and Grading Plans

Rough grading plans are shown in Figures 3a-e.

G. Clearing and Grading Narrative

The CGS project site will require earthwork to construct the generating and associated facilities, including the bridge replacements. Soil disturbing activities will include grubbing and clearing, rough grading, excavating, filling, and final grading. For all areas where earthwork will be executed, materials suitable for compaction will be stockpiled in designated on-site locations. Materials not suitable for compaction will be stored in separate stockpiles and reused on the site, as appropriate. Any contaminated materials encountered during excavation will be disposed of in accordance with applicable laws, ordinances, regulations, and standards.

The Construction Contractor will perform clearing and grubbing of the construction areas using scrapers or the equivalent. Clearing and grubbing will start on the 100-acre site area and last approximately three months. Areas cleared and grubbed will be smoothed by earthwork equipment, possibly a grader or similar piece of equipment, and compacted by vibrating rollers. Concrete, mechanical and electrical works will be performed over a period of 15 months, with the aid of graders, rollers, front loaders, dump trucks, trenching machines, concrete mixer and pump trucks, cranes, and pick-ups. Table 3 outlines the amount of cut and fill planned for specific components of the project. The entire cut and fill activity is considered permanent. The surplus material will be permanently stockpiled on the north side of the project site. The surplus material stockpile will be graded, contoured, and seeded with native grasses consistent with the requirements of the Biological Resource Condition of Certification BIO-18. No material will need to be imported or exported.

TABLE 3
Clearing and Grading

Description	Stockpile (yd^3)	Total Cut (yd^3)	Total Fill (yd^3)
Power Block	26,583	172,739	74,074
Entrance Access Road	5,000	32,491	18,000
4” Pipeline Service Road	10,000	64,981	36,000
Employee Parking	5,556	36,104	20,002
East Lay Down Area	8,518	55,351	30,665
West Lay Down Area	7,037	45,727	25,333
Contractor Trailer Area	2,555	16,603	9,198
Switchyard	5,926	38,508	21,334
Total	71,175	462,503	234,605

yd^3 = cubic yards

The following subsections provide a discussion of clearing and grading associated with each of the major construction elements of the project.

Power Block and Switch Yard Areas

Earthwork in the power block area will consist of removal of topsoil, vegetation, and debris; excavation and compaction of earth to create the plant grade; and excavation for foundations and underground systems. Approximately 211,247 yd^3 of cut and 95,408 yd^3 of fill will be required to provide a level pad for the power block and switchyard.

The switchyard area will be graded as a level pad sloped to drain to the east and west. Perimeter drainage ditches will direct all runoff south towards the power block. Developing this surface will require adding fill material on the east side of the yard, and cutting into existing found on the west side to accommodate the proposes switch yard foot print, with additional cut back into the existing slope at a minimum angel of 3:1 to provide space for diversion ditches.

All runoff from the power block and switch yard will be discarded to Sediment Basin No. 3 on the southwest corner of the site, which will be formed by excavation and embankment construction as necessary to provide a sufficient volume for the control of sedimentation from the disturbed area. This basin will be converted to a storm water management pond at the end of the construction period.

Temporary Offices and Construction Parking

A 6.2-acre area on the east side of the site will be graded and covered in gravel for construction parking. Approximately 36,104 yd^3 of cut and 20,002 yd^3 of fill will be required to grade this area of the site. Runoff from this area will be directed to Sediment Basin No. 2. After construction, the riser will be removed from this basin and the outfall pipe will be retained as a culvert for local drainage. Because a large part of the area currently draining to this outlet will be redirected to the south after development, no storm water management will be required for this basin.

An additional 2 acres just south of the parking lot will be graded as a pad for the construction of temporary offices. Approximately 16,603 yd^3 of cut and 9,198 yd^3 of fill will be required to grade this area of the site. Temporary and permanent roads and associated drainage ditches will be installed.

Runoff from this area will be directed to Sediment Basin No. 4 during construction, which is sized in accordance with BMP standards published by the State of California. After construction is complete, the basin will be converted to a Stormwater Management Pond to attenuate peak discharges to predevelopment levels as required.

Laydown Area

The construction laydown area is located on the north side of the project site. Approximately 101,078 yd^3 of cut and 55,998 yd^3 of fill will be required to make this area ready for construction. Activities include clearing, grubbing, cut and fill operations, and the placement of gravel surface stabilization. The existing natural swale will be improved as a temporary drainage channel between the two pads with smaller drainage ditches along their outboard edges.

An embankment across the outlet of the subbasin will be constructed to form the downstream side of a sediment basin, and grading will be provided to divert all runoff from the upstream side area into the sediment basin. Excavation will be carried out upstream of the embankment as necessary to provide the storage volume required for sediment control.

The upper 12 inches of top soil will be stockpiled and seeded on the north side of the site. The stockpile will be surrounded by a perimeter silt fence. The vegetation placed on the stockpile shall be inspected regularly to ensure that adequate moisture is applied to maintain the vegetative cover reducing erosion and dust. Additionally, care shall be used to not apply too much water and cause erosion of the stockpile from runoff.

Figure 8a shows a typical laydown area and BMPs. Before placement of the gravel pad for the lay down area, topsoil will be stripped and geotextile fabric will be placed over the existing soil surface. During construction activities, monitoring and maintenance of the lay down areas will be performed. Once construction is complete, the gravel and geotextile will be removed. Sediment removed from the storm water management basin will be spread over the lay down area and then the topsoil replaced and seeded to restore the area to predevelopment conditions.

Bridge Replacement Sites

Earthwork associated with the bridges is expected to be minimal. All BMPs included in this DESCP and the SWPPP shall be implemented to prevent runoff from rain and wash water from entering the canals/creek. The sediment control measures that will be employed during the construction of these linear facilities are described in Section E, Drainage Narrative and Section I, Best Management Practices Narrative.

Offsite Clearing and Grading

Offsite clearing and grading includes earthwork associated with permanent access roads for entering the facility and temporary access for the construction of the gas and water pipelines. Earthwork associated with the roads includes excavation for the preparation of the subbase and side ditches and the placement and compaction of suitable drainage layers and fill, to be determined by the project civil engineer at a later date. Volumes of cut and fill associated with this work are expected to be minimal.

Standard installation techniques will be employed for the gas and water pipelines associated with the project. Figure 8b shows the typical paved and unpaved trenching scenarios and associated BMPs. Excavations will be of the minimum width compatible with proper installation and safety requirements. Specifically, excavations associated with the back-up water supply line assume a 2-foot-wide area of disturbance for the segment of the pipeline located within the paved road and a 30-foot-wide area of disturbance for the segments located in unpaved areas, totaling 0.93 acres of disturbance. The trenches will be closed as soon after the placement of the pipeline as is technically feasible, with every effort made to minimize the time in which excavations remain open. Areas disturbed in association with installation of the new back-up water supply line will be returned to pre-construction conditions or equivalent condition at the end of the work day. However, if open trenches are not backfilled at the end of each business day, implement trench plates to stabilize disturbed areas and protect soils from erosion by wind or water.

Plastic covers are to be used to stabilize disturbed soil areas along the trenches and stockpiles to protect soils from erosion. The stockpiles shall be covered with plastic and secured with gravel bags. Wattles shall be placed at the base of all stockpiles. Erosion control blankets shall be placed at slopes steeper than 4:1 to stabilize the disturbed areas and protect slopes from erosion. Fiber rolls with 20′ spacing will be used for slopes flatter than 4:1.

H. Best Management Practices

Figures 9a-d show details of the BMPs to be employed during project construction and Figures 10a-c show the specific locations of the BMPs. Because the Teresa Creek Bridge replacement is still in the conceptual design phase, a detailed site map showing the location of the prescribed BMPs is not available at this time. Once the design is finalized and prior to any soil disturbance at the Teresa Creek Bridge replacement site, PG&E will update this DESCP and the Construction Stormwater Pollution Prevention Plan (SWPPP). A discussion of the various BMPs being utilized is provided in the next section. As part of the SWPPP, a current version of these two drawings are maintained in the project construction trailer and updated regularly to reflect modified or new BMPs that are being implemented and maintained on site.

I. Best Management Practices Narrative

The project construction schedule is provided in Table 4. An implementation and maintenance schedule for the drainage, erosion, and sediment control methods and practices that will be implemented at the CGS project site are included in Table 5.

TABLE 4
Key Construction Events

Event Description	Expected Dates and Essential Biological Resource Protection Measures
Date of Certification by CEC	April 23, 2008
Start of Rainy Season	October 15 (Typical) *Project site and linears must have SWPPP protection measures implemented*
End of Rainy Season	April 15 (Typical)
Construction of the CGS Property Fence Line	July 7, 2008-July 21, 2008 *Biological Monitor required to clear/survey area for wildlife prior to any ground disturbance on the project. Install exclusion fencing at alkali grassland.*
Construction of New Access Road, Laydown, Parking and Construction Offices	July 19, 2008-August 6, 2008 *Biological Monitor required to clear/survey area for wildlife prior to any ground disturbance on the project.*
Repaving of Existing Access Road West of the Glenn-Colusa Canal Bridge	Prior to October 1, 2010 *No work in giant garter snake habitat (wetlands adjacent to canal) between October 1 and May 1. Wetland protection (silt fencing) measures to be in place at all times.*
Power Plant Construction	July 1, 2008-October 1, 2010 *Biological Monitor required to clear/survey area for wildlife prior to any ground disturbance on the project. Silt fencing required around project site perimeter to exclude California tiger salamander and other wildlife.*
Glenn-Colusa Canal Jumper Bridge	Foundation preparation August 8, 2008-August 12, 2008 Install/set in place jumper bridge January 19, 2009-August 14, 2009 *No work in giant garter snake habitat (wetlands adjacent to canal) between October 1 and May 1. Wetland protection (silt fencing) measures to be in place at all times. Nesting swallows require protection.*
Teresa Creek Bridge Removal and Replacement	July 7, 2008-August 7, 2008 *No work in giant garter snake habitat (wetlands adjacent to canal) between October 1 and May 1. Any trapped fish needs captured and relocated in dewatered construction areas. Wetland protection (silt fencing) measures to be in place at all times. Nesting swallows require protection.*

TABLE 4
Key Construction Events

Event Description	Expected Dates and Essential Biological Resource Protection Measures
Northern and Southern Transmission Line Interconnection	Date to be determined *Work near vernal pools must be completed during the period from April 15 to October 15; No construction within 250 feet of vernal pools. No construction activities within 250 feet of active burrowing owl burrows from February 1 to August 31 and within 160 feet of occupied burrowing owl burrow from September 1 to January 31).*
Water Intake Construction at Tehama-Colusa Canal, Supply Line, and Service Road Construction	July 19, 2008-August 20, 2008 *Construction limited to April 15 through October 15, or provide silt fencing from October 16 through April 14 to exclude/protect California tiger salamander. Biological Monitor required to clear/survey area for wildlife prior to any ground disturbance on the project.*
Roadway Widening at Delevan/McDermott Road Intersection	August 8, 2008-August 12, 2008 *No work in giant garter snake habitat (wetlands adjacent to road) between October 1 and May 1. Wetland protection (silt fencing) measures to be in place at all times during the period from May 1 to October 1.)*
Natural Gas Pipeline Construction	Date to be determined *Biological Monitor required to clear/survey area for wildlife prior to any ground disturbance on the project. Silt fencing required around project site perimeter to exclude California tiger salamander and other wildlife.*
Completion of Construction	August 1, 2010
Start of Operation	August 2, 2010
Biological Resources Post Construction Report	Due 30 days after construction is complete (expected June 2010).

TABLE 5
BMP Implementation and Maintenance Schedule

Best Management Practices	Implementation	Inspection Frequency	Maintenance
Silt Fence	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Replace torn sections, repair up-rooted sections, clean out collected soils when greater the 1/3 height of fence

TABLE 5
BMP Implementation and Maintenance Schedule

Straw Wattle Dikes	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Replace crushed sections, replace rotted sections, clean out collected soil when greater than 1/3 height of roll
Coir logs (rolls)	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Replace crushed sections, replace rotted sections, clean out collected soil when greater than 1/3 height of roll
Sandbags	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Repair, reshape, replace bags as necessary, replace bags exposed to sunlight every 2 to 3 months, clean out collected soil when greater than 1/3 height of bag
Gravelbags	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Repair, reshape, replace bags as necessary, replace bags exposed to sunlight every 2 to 3 months, clean out collected soil when greater than 1/3 height of bag
Gravel	Two weeks prior to construction	If placed, must be inspected before and after rain events for evidence of erosion (and once each 24-hour period during extended storm events)	Replace gravel lost to erosion
Seeding	As possible after disturbance has permanently or temporarily ceased, but in no case more than 14 days after the construction activity in an area has ceased (Except when construction activity will resume on that portion of the site within 21 days)	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season (Monitored every May for the first three years following project completion)	Areas that do not meet revegetation criteria will be reseeded

TABLE 5
BMP Implementation and Maintenance Schedule

Permanent revegetation	As possible after disturbance has permanently or temporarily ceased, but in no case more than 14 days after the construction activity in an area has ceased (Except when construction activity will resume on that portion of the site within 21 days)	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season (Monitored every May for the first three years following project completion)	Areas that do not meet revegetation criteria will be reseeded
Erosion control blankets	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Replace/repair as necessary
Geotextiles and Mats	During construction activities	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Replace/repair as necessary
Bio-logs	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Replace crushed sections, replace rotted sections, clean out collected soil when greater than 1/3 height of roll
Straw bales	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events) and once a week during dry periods	Clean out collected soil when greater than 1/3 height of roll

TABLE 5
BMP Implementation and Maintenance Schedule

Sediment Basin	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Examine basin banks for seepage and structural soundness, check inlet and outlet structures and spillway for any damage or obstructions, repair damage and remove obstructions as needed, sediment should be removed when sediment accumulation reaches one half the designated sediment storage volume, remove standing water from basin within 72 hours after accumulation, remove accumulation of live and dead floating vegetation in basins during every inspection, remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies
Tire wash station	Two weeks prior to construction	Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Remove accumulated sediment in wash rack and/or sediment trap to maintain system performance and inspect routinely for damage and repair as needed
Trench Plates	During construction activities	Install daily as needed over open trenches. Inspect before and after storm events (and once each 24-hour period during extended storm events), once a week during rainy season, and bi-weekly during dry season	Replace/repair as necessary
Aggregate surfacing	Two weeks prior to construction	Once a week during rainy season and bi-weekly during dry season	Keep all temporary roadway ditches clear, periodically apply additional aggregate on gravel roads, active dirt construction roads are commonly watered three or more times per day during the dry season.

The following describes the BMPs that will be implemented during the pre-construction, construction, and post-construction phases of the project.

Good Housekeeping. Good housekeeping practices are designed to maintain a clean and orderly work environment. The good housekeeping practices listed below will be followed to reduce the risk of potential pollutants entering storm water discharges. All construction personnel will be responsible for monitoring and maintaining housekeeping tasks and reporting potential problems to the Contractor's Site Manager:

- Store only enough products required for doing the job.
- Store all materials in a neat and orderly manner in the appropriate containers. Materials that may adversely impact storm water, such as: paint, oils, greases, sealers, etc., will be stored in covered areas such as temporary/permanent buildings or trailers, in accordance with the SWPPP.
- Keep products in the original container with the original manufacturer's label.
- Do not mix products unless recommended by the manufacturer.
- Use all of a product before disposing of the container.
- Cover and berm loose stockpiled construction materials that are not actively being used.
- Use and dispose of products according to the Contractor's Site Manager's direction or manufacturer's recommendations.
- Perform regular inspections of the storm water system and the material storage areas.
- Minimize exposure of construction materials to precipitation.
- Implement BMPs to prevent tracking loose construction and landscape materials offsite.
- Contain and securely protect stockpiled waste materials from wind and rain at all times unless actively being used.
- If open trenches are not backfilled at the end of each business day, implement trench plates to stabilize disturbed areas and protect soils from erosion by wind or water.
- Limit the use of plastic materials when more sustainable environmentally friendly alternatives exist.
- When and where appropriate, use posters, bulletin boards, or meetings to remind and inform construction personnel of required procedures.
- Preventive maintenance includes regular inspection and maintenance of structural storm water controls (catch basins, oil water separators, etc.) as well as other facility equipment and systems.

Storage areas for hazardous materials such as oils, greases, paints, fuels, and chemicals will be provided with secondary containment to ensure that spills in these areas do not reach storm water. All hazardous chemical storage areas will be surrounded by curbs or dikes to contain the chemicals in the event of leaks or spills. The Contractor shall establish contingencies for the proper disposal of contaminated soils (use of licensed hauler, approved landfill) early in the construction period. Secondary containment will be designed to hold the entire contents of the largest single storage container plus rainfall from a 50-year, 24-hour storm for all outdoor storage areas. Curbs and dikes will be provided around all chemical storage areas, hazardous waste products, areas with possibility of oil spill (i.e., transformers) and washout areas.

Spills and leaks are one of the largest potential sources of storm water pollutants at industrial facilities. Chemicals will be stored in chemical storage facilities appropriately designed for their individual characteristics. Bulk chemicals will be stored outdoors in aboveground storage tanks. Other chemicals will be stored and used in their delivery containers. All hazardous chemical storage areas will be surrounded by curbs or dikes to contain the chemicals in the event of leaks or spills. Secondary containment will be sized to hold the entire contents of the largest single storage tank. All drains and vent piping for volatile chemicals will be trapped and isolated from other drains. Containment areas for bulk storage tanks will not be drained. Any chemical spills in these areas will be removed with portable equipment and reused or properly disposed. It is anticipated that all substances will be applied/dispensed at manufacturer's recommendations.

In addition to the housekeeping and hazardous materials storage procedures described above, spill prevention and cleanup practices will be as follows:

- PG&E's Site Manager or appointee is responsible for informing construction personnel of the manufacturer's recommended spill cleanup methods, and the location of that information and cleanup supplies.
- Materials and equipment for the cleanup of a relatively small spill will be kept in the materials storage area. These facilities may include brooms, rags, gloves, shovels, goggles, sand, sawdust, absorbent, plastic or metal trash containers, and protective clothing.
- All containers will be labeled, tightly sealed, and stacked or stored neatly and securely.

Spill response procedures will be as follows:

- Step 1: Upon discovery of a spill, stop the source of the spill.
- Step 2: Cease all spill material transfer until the release is stopped and waste removed from the spill site.
- Step 3: Initiate containment to prevent spill from reaching State waters.
- Step 4: Notify Supervisor and PG&E's Site Manager of the spill.
- Step 5: PG&E's Site Manager will immediately notify the PG&E emergency coordinator, and coordinate further cleanup activities
- Step 6: Any significant spill of hazardous material will be reported to the appropriate state and/or local agencies by PG&E personnel or qualified contractors. Table 6 lists the project's environmental emergency contacts.

TABLE 6
Environmental Emergency Telephone List

Company/Organization	Telephone Numbers

TABLE 6
Environmental Emergency Telephone List

Company/Organization	Telephone Numbers
Pacific Gas and Electric	
PG&E Environmental Specialist:	(530) 934-9007
PG&E Media Representative:	(415) 973-5930
PG&E Headquarters Telephone Operator:	(415) 973-7000
PG&E Safety Health & Claims Hotline:	(415) 973-8700
Other Resources	
3E Company (MSDS by FAX):	(800) 451-8346
Chemtrec (emergency chemical information):	(800) 424-9300
Poison Control Center:	(800) 662-9886
Federal Agency	
U.S. Coast Guard/National Response Center:	(800) 424-8802
State Agencies	
California Office of Emergency Services (OES):	(800) 852-7550
California Department of Toxic Substances Control (DTSC)*:	(800) 852-7550
California Department of Fish and Game*:	(800) 852-7550
California State Lands Commission:	(562) 590-5201
Regional Water Quality Control Board (RWQCB)*:	(800) 852-7550
Local Contacts	
Administering Agency – Colusa County Health and Human Services Department:	(530) 458-0250
Fire – Maxwell Fire Protection District:	911 or (530) 438-2320
Sheriff – Colusa County Sheriff's Department:	911 or (530) 458-0200
Hospital – Colusa Regional Medical Center:	911 or (530) 458-5821
Ambulance/Paramedics:	911

* DTSC, RWQCB and California Department of Fish and Game have requested that emergency notifications to these offices be made through the OES 800 number.

- Step 7: Submit a Notice of Discharge Form within 7 days of the discharge event.
- Step 8: Review the construction storm water pollution prevention plan and amend, if needed. Record a description of the spill, cause, and cleanup measures taken.

Inspection, Maintenance, and Recordkeeping Procedures. Site inspection and facility maintenance are important features of an effective stormwater management system. The Contractor's qualified personnel will inspect disturbed areas of the site that have not been stabilized, storage areas exposed to precipitation, all control measures, and site access areas to determine if the control measures and stormwater management system are effective in preventing significant impacts to receiving waters.

Inspections will be performed before and after storm events and once each 24-hour period during extended storm events to identify BMP effectiveness and implement repairs or design changes as soon as feasible depending on field conditions. The discharger will complete an inspection checklist, which will include the following information:

- Inspection date
- Weather conditions
- A description of any inadequate BMPs
- List of observations of all BMPs
- Corrective actions required, including any changes to DESCP
- Inspector name, title, and signature

Erosion and Sediment Controls. The following procedures will be used to maintain erosion and sedimentation controls:

- All control measures will be inspected before and after storm events and once each 24-hour period during extended storm events.
- All measures will be maintained in good working order; if a repair is necessary, that repair will be initiated within 24 hours of the report.
- Sediment will be removed from the silt barriers when it has reached one-third of the height of the barrier.
- Silt barriers will be inspected for depth of accumulated sediment, tears, attachment to posts, and stability on a weekly basis.
- Plastic covers and gravel bags shall be inspected for tears and stability on a weekly basis.
- If open trenches are not backfilled at the end of each business day, implement trench plates daily to stabilize disturbed areas and protect soils from erosion by wind or water.
- Aggregate-covered areas will be inspected for bare spots and washouts.
- The PG&E Site Manager will select individuals to be responsible for inspections, maintenance, repairs, and reporting. The designated inspectors will receive the necessary training from PG&E's Site Manager to properly inspect and maintain the controls in good working order.
- An Inspection Form will be completed after each inspection.
- The completed Inspection Forms will be retained onsite.

Non-Stormwater Controls. The following procedures will be used to maintain the non-stormwater controls:

- All control measures will be inspected before and after storm events and once each 24-hour period during extended storm events.
- All measures will be maintained in good working order; if a repair is necessary, that repair will be initiated within 24 hours of the report.
- The designated inspector will visually observe all drainage areas for the presence of unauthorized non-stormwater discharges and their sources.

- If a spill occurs that cannot be cleaned up before the next rain event, or under other circumstances warranting sample collection, the designated inspector will collect stormwater samples during the first two hours (even including weekends or holidays) of discharge. Similarly, if it appears that BMPs have failed or been damaged to the extent that they could result in discharge of pollutants in stormwater; and are discharging potentially impacted water, samples should be collected. Another instance that requires sampling is where stormwater comes in contact with exposed materials that could potentially contaminate stormwater runoff. The samples should be analyzed for visible and non-visible compounds with the analytical testing suite determined from the specific materials spilled or not contained properly, and for any constituents in the spill that occur in high enough concentrations to cause an impact to water quality.
- The PG&E Site Manager will select individuals to be responsible for inspections, maintenance, repairs, and reporting. The designated inspectors will receive the necessary training from PG&E's Site Manager to properly inspect and maintain the controls in good working order.
- An Inspection Form will be completed after each inspection.
- The completed Inspection Forms will be retained onsite.

Recordkeeping. Two inspection forms will be completed demonstrating that inspections and maintenance of the control measures are implemented: Erosion and Sedimentation Controls, and Non-stormwater Source Controls. All disturbed areas and materials storage areas require inspection at least every 1 day before and after storm events and once each 24-hour period during extended storm events. After each inspection, the inspector completes an inspection report and retains a copy of the report. Any maintenance required is initiated within 24 hours of the inspection.

A copy of this DESCP and any supporting materials must be maintained at the construction site from the date of CEC approval to the date of final stabilization. All records and supporting documents will be compiled in an orderly manner, and maintained onsite until final site stabilization is completed.

The generation of reports, as part of the construction process and inspection or amendment procedures, provides accurate records, which can be used to evaluate the effectiveness of this DESCP and document compliance. Changes in design or construction of the stormwater management system are documented and included with the DESCP to facilitate review or evaluation.

Figures

FIGURE 1 – PROJECT VICINITY

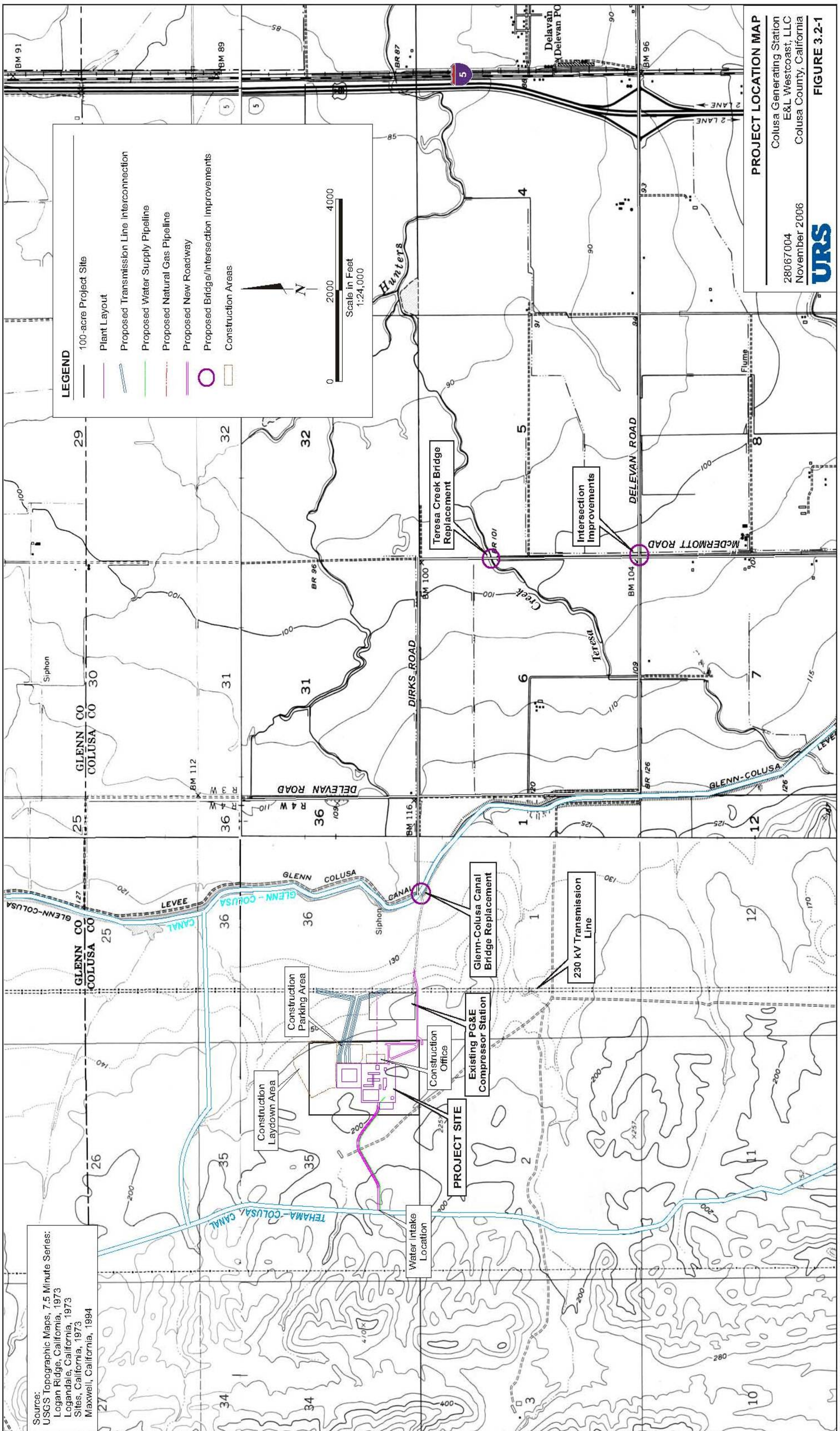


FIGURE 2A – DETAILED SITE PLAN

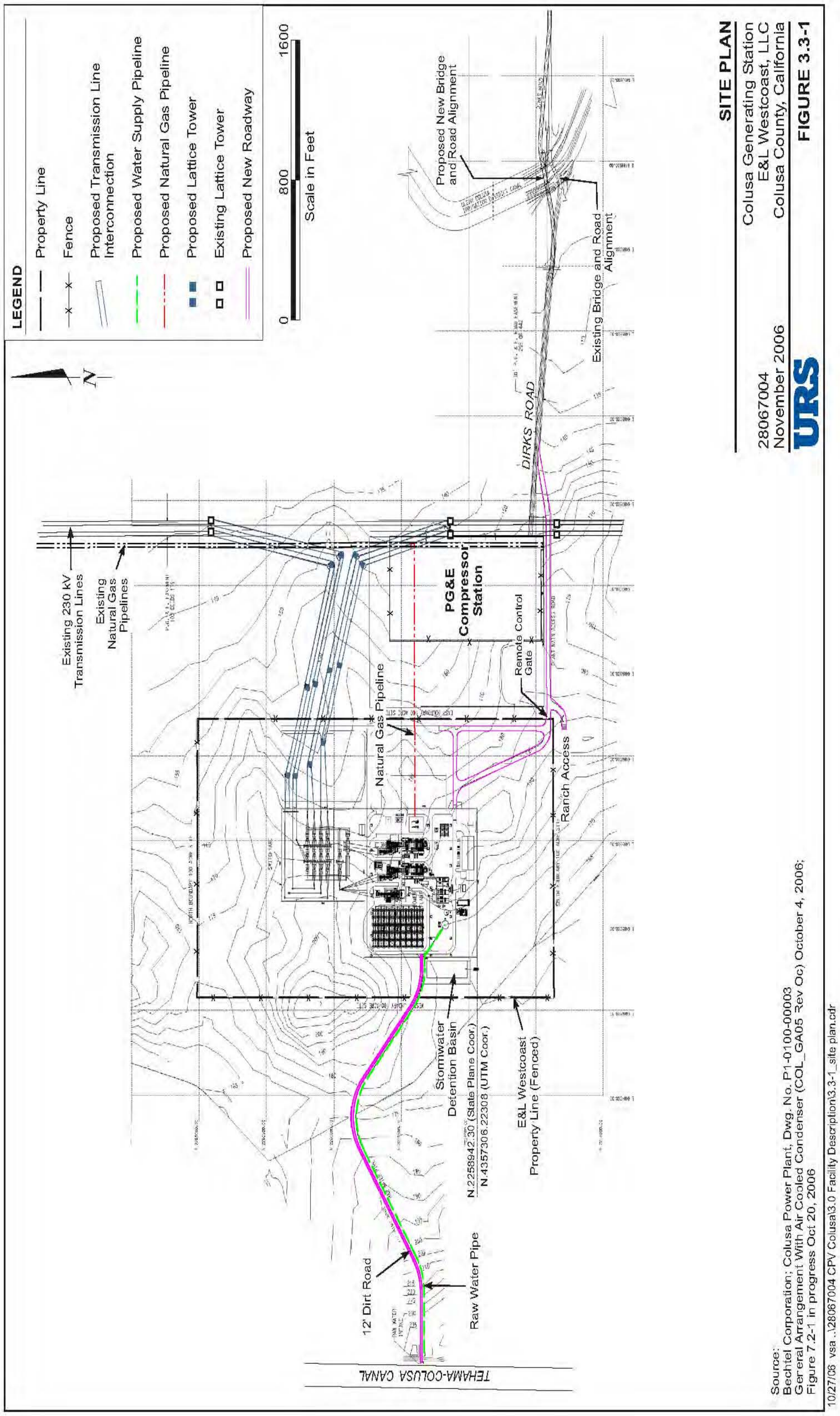


FIGURE 2B – DETAILED SITE PLAN – WATER SUPPLY PIPELINE

Figure 2b
Detailed Site Plan - Water Supply Pipeline
Colusa Generation Station
Pacific Gas And Electric Company
Proposed Water Intake Structure and 6-inch Waterline
Colusa County, CA

FIGURE 3A – ROUGH GRADING PLAN – MAIN PLANT AREA

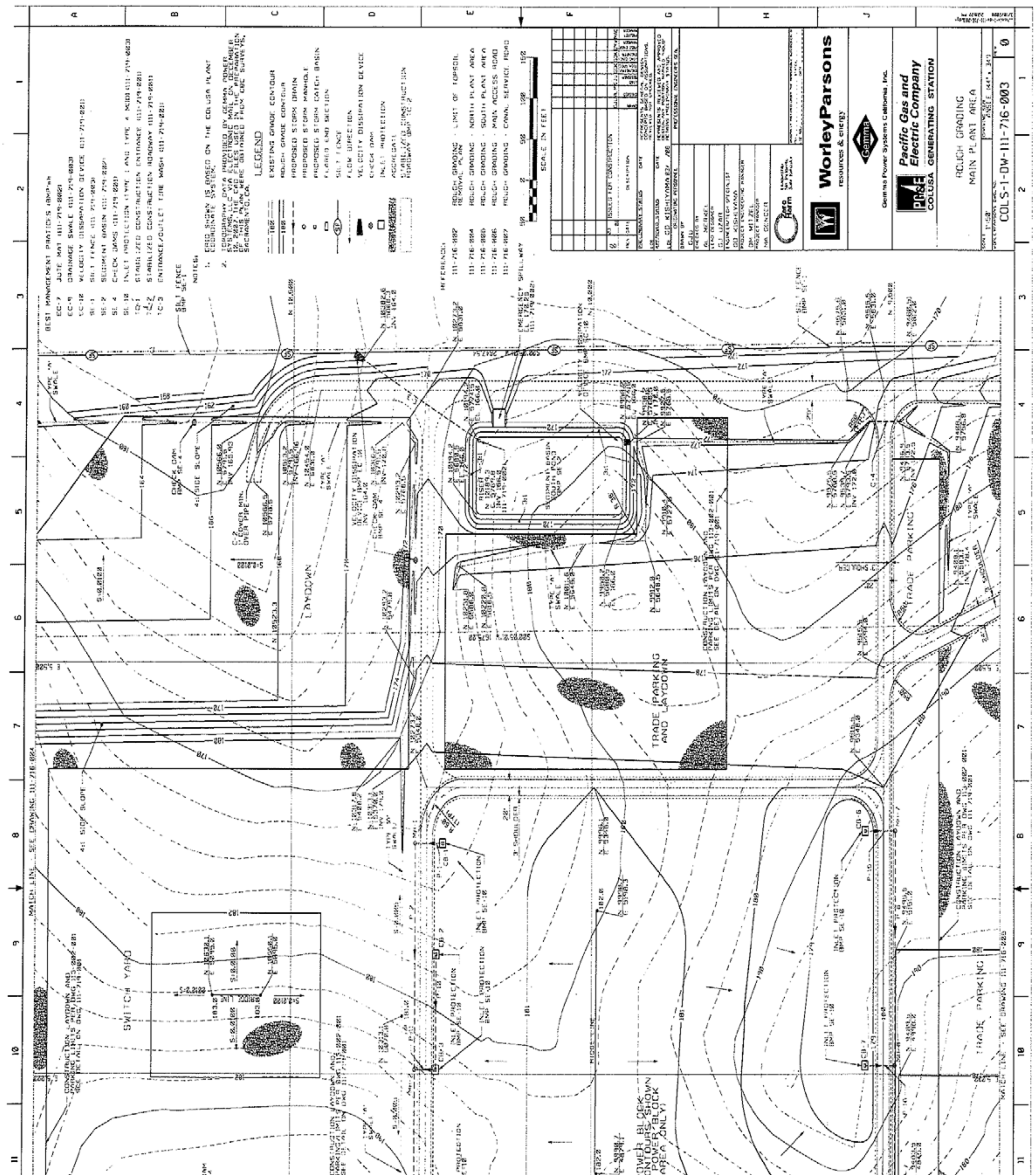


FIGURE 3B – ROUGH GRADING PLAN – NORTH PLANT AREA

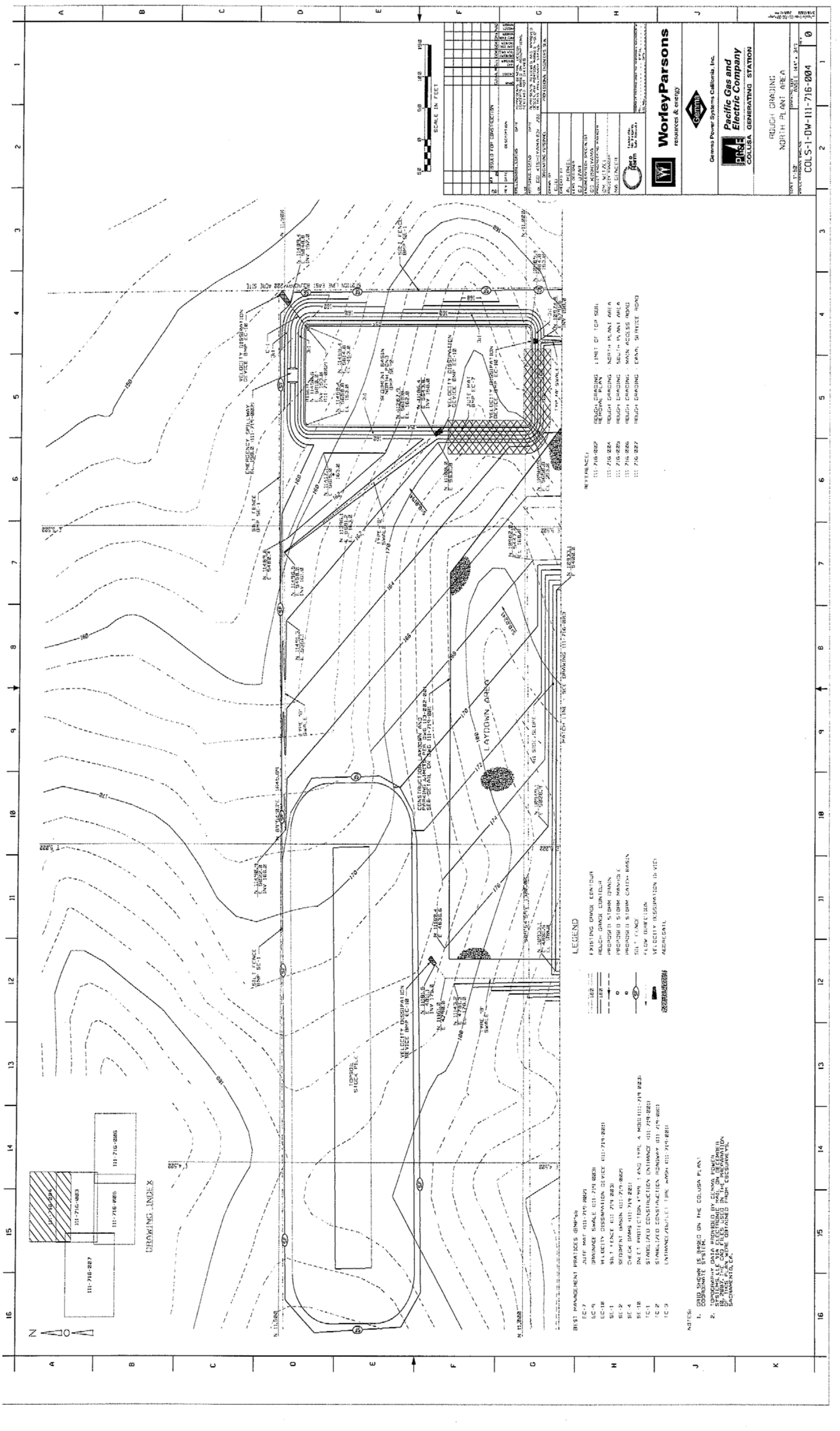


FIGURE 3C – ROUGH GRADING PLAN – SOUTH PLANT AREA

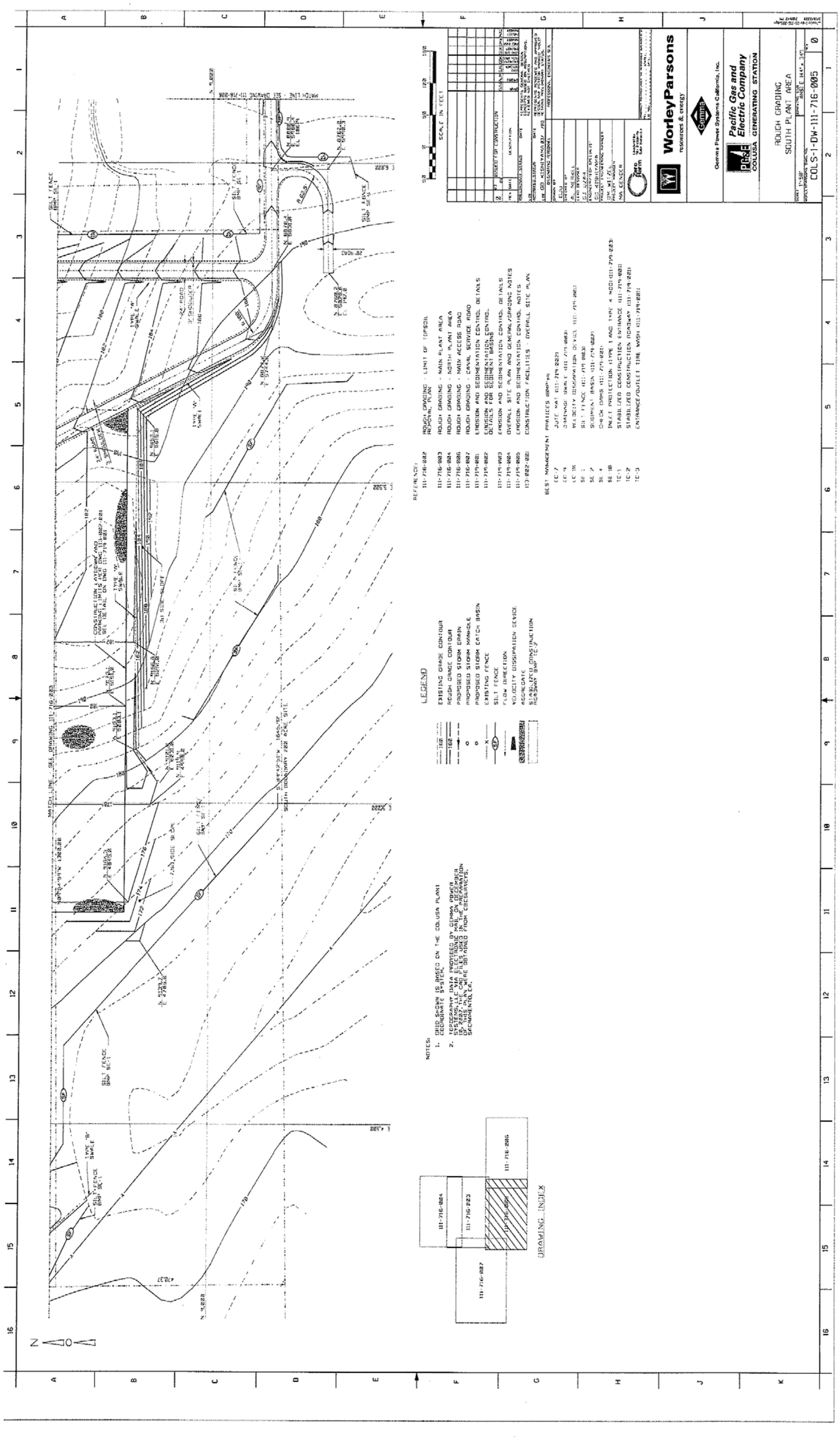


FIGURE 3D – ROUGH GRADING PLAN – MAIN ACCESS ROAD

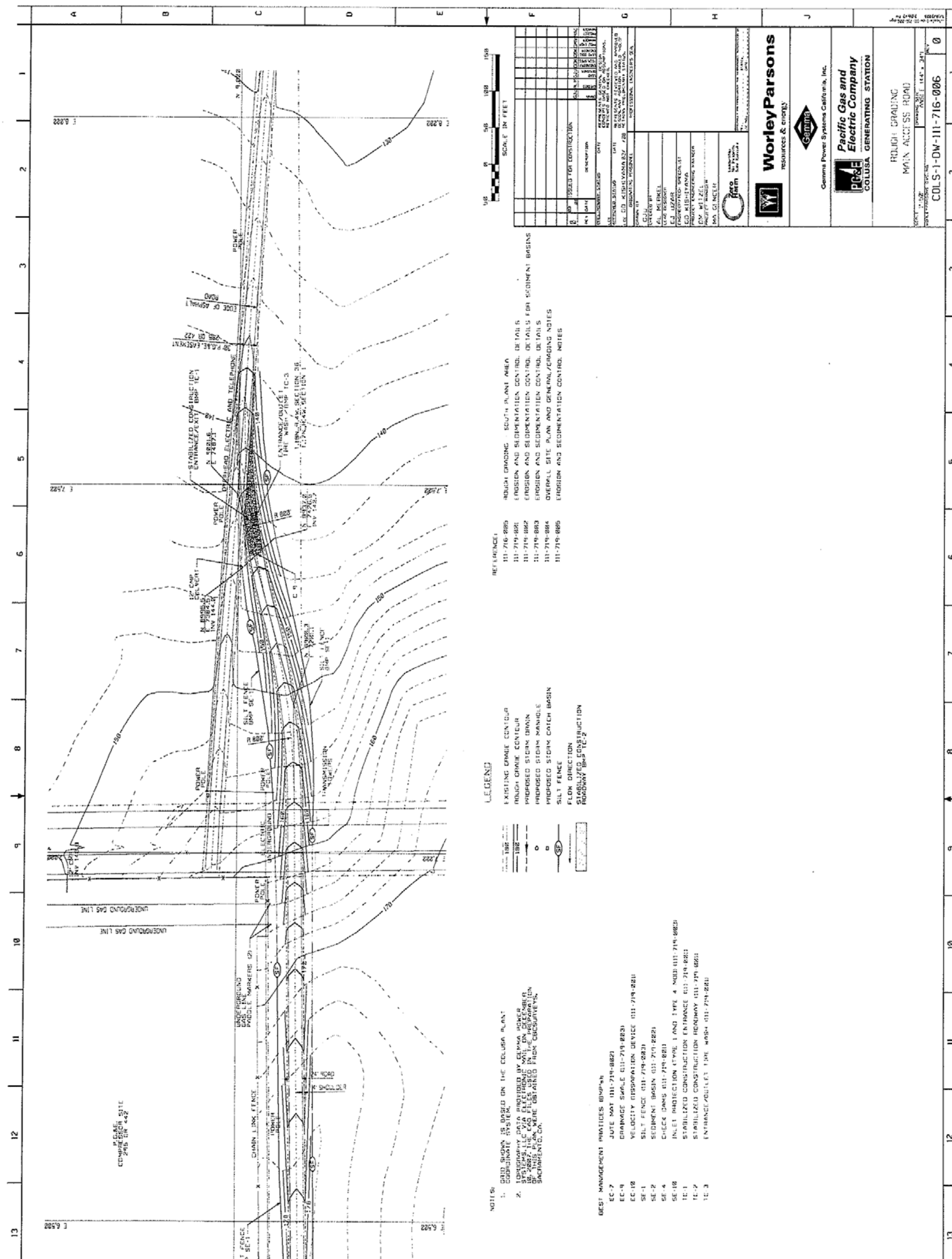


FIGURE 3E – ROUGH GRADING PLAN – CANAL SERVICE ROAD

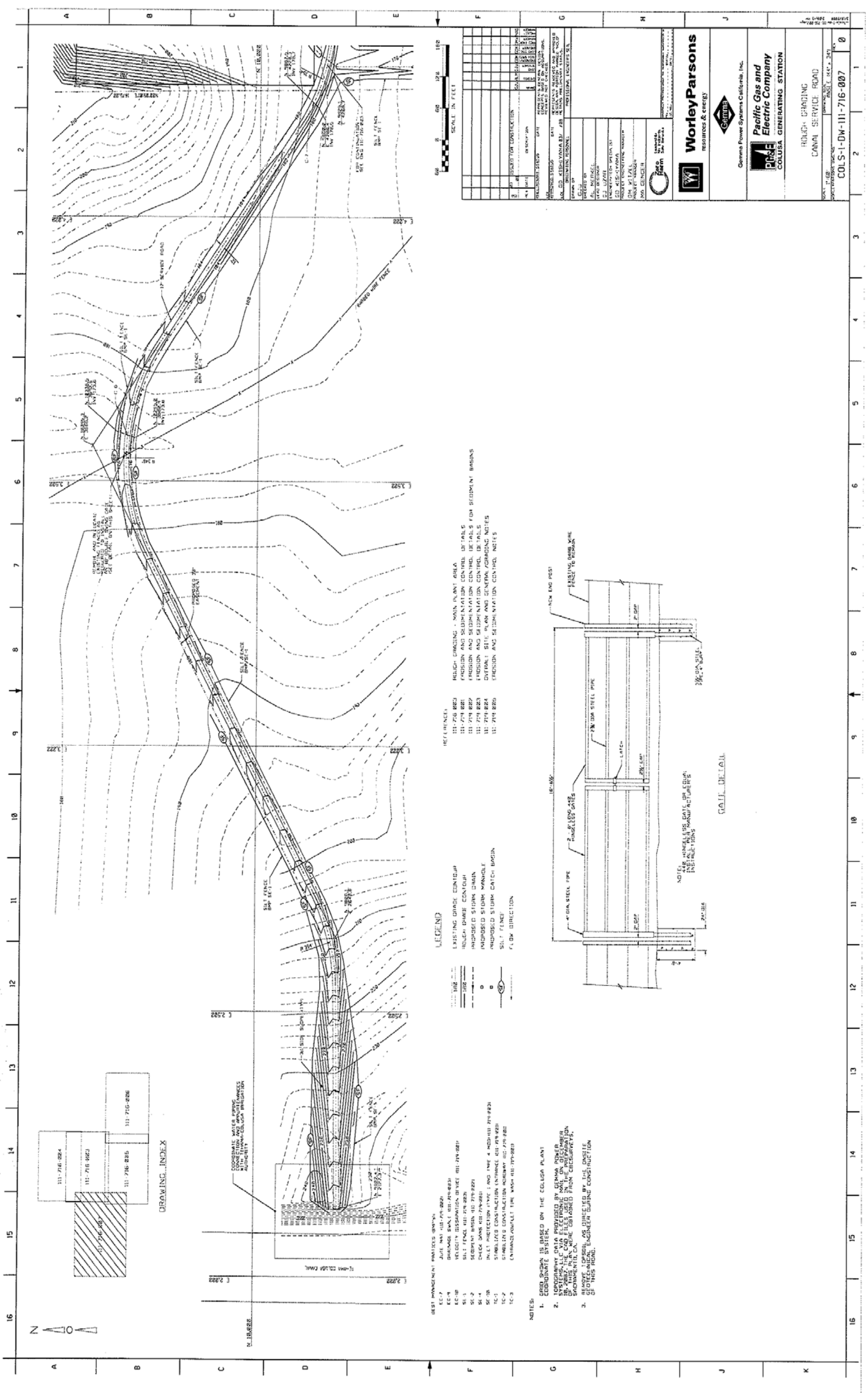


FIGURE 4 – SENSITIVE AREAS

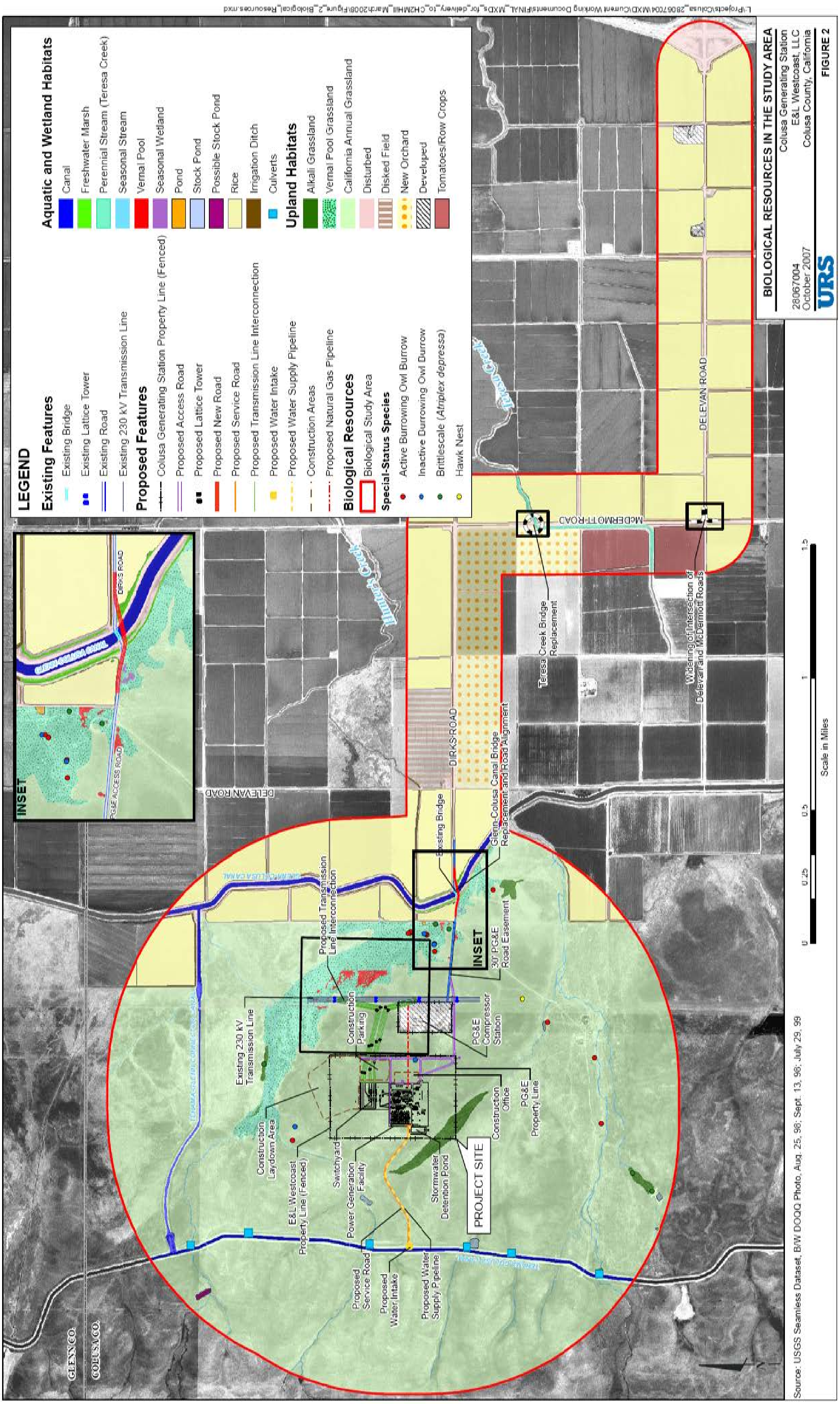


FIGURE 5A – PRE-DEVELOPMENT DRAINAGE AREAS AND FLOW PATHS

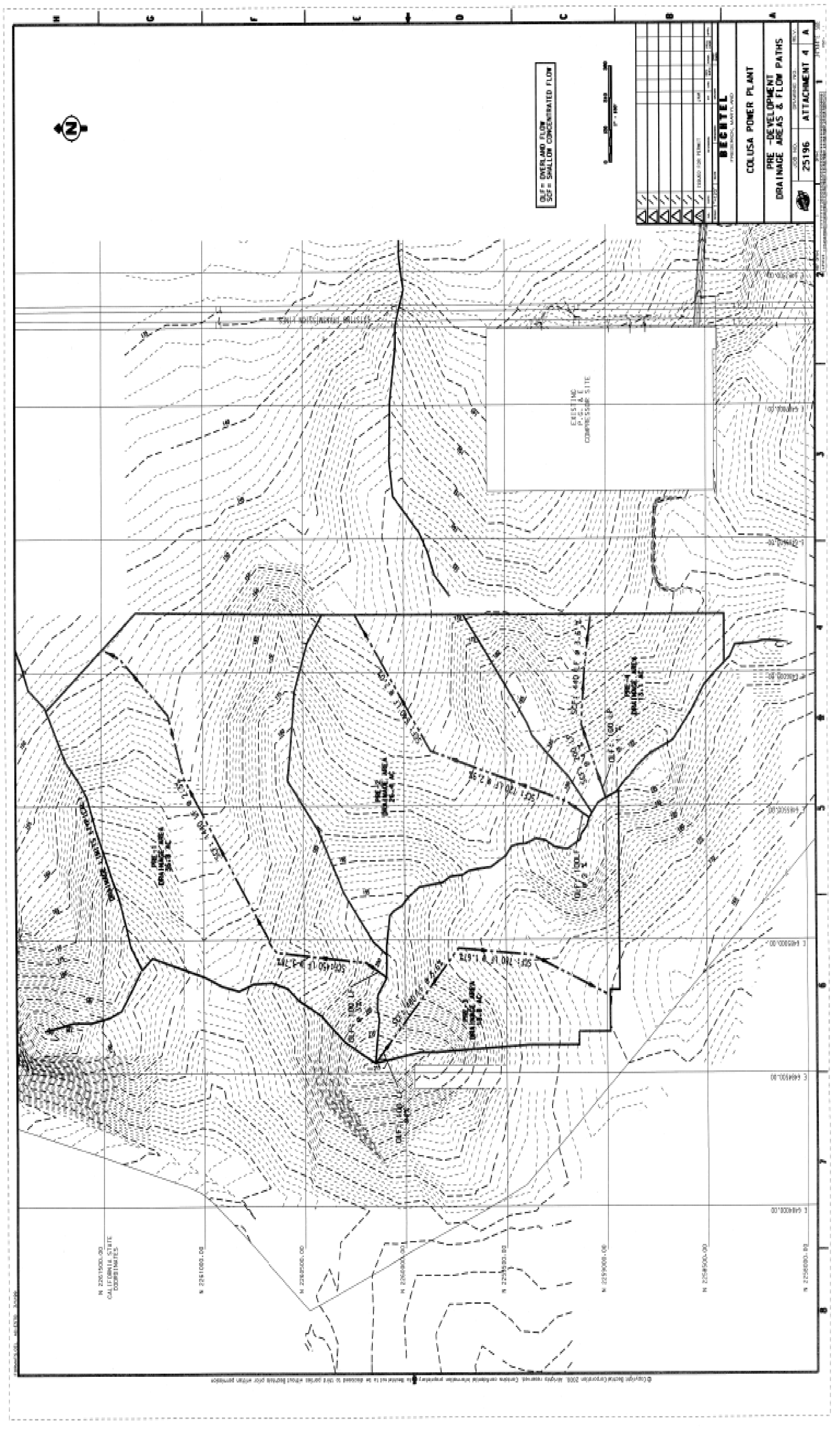


FIGURE 5B – POST-DEVELOPMENT DRAINAGE AREAS AND FLOW PATHS

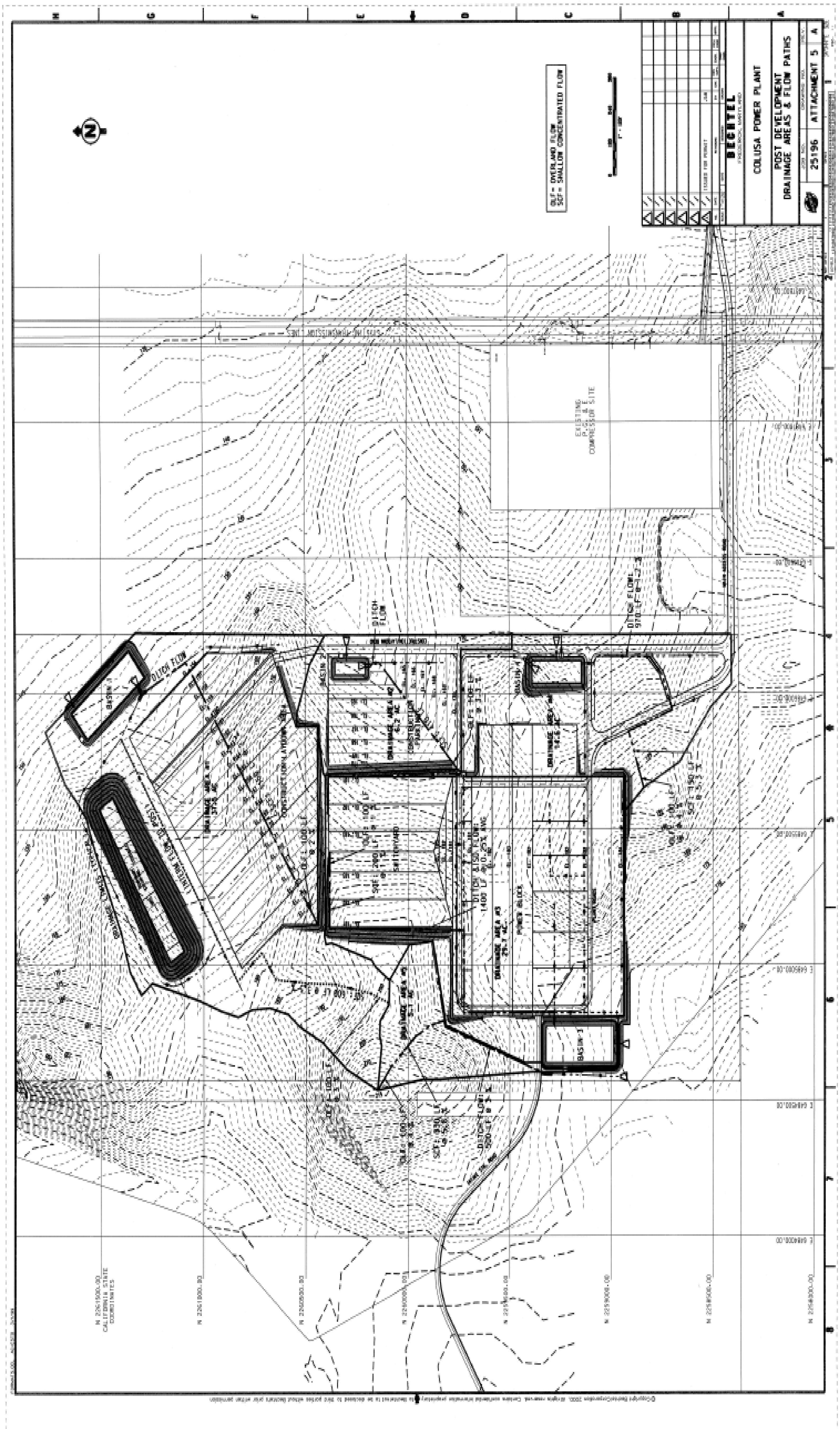


FIGURE 5C – DRAINAGE DETAILS

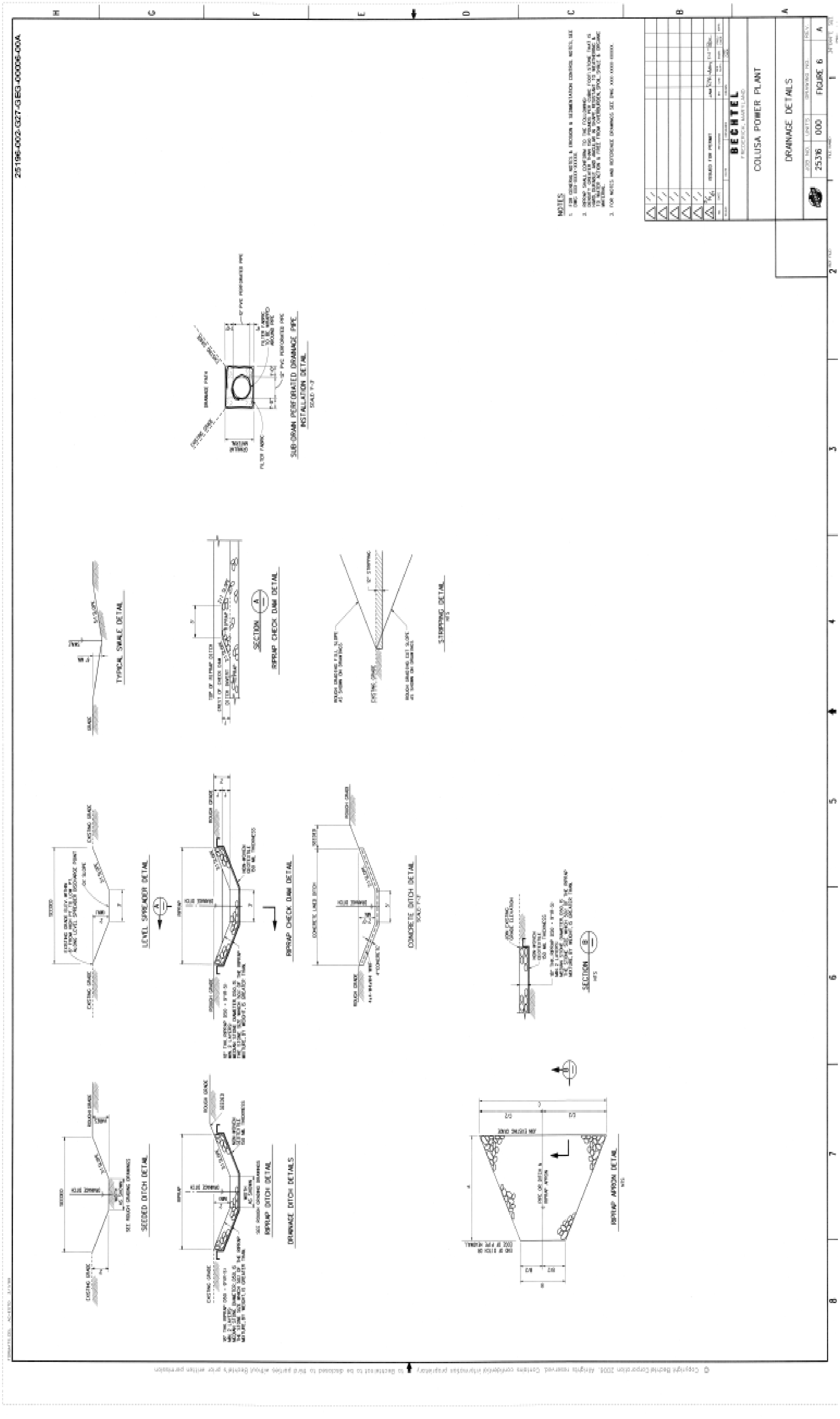


FIGURE 6 – DRAINAGE AREAS – LAND PRE-DEVELOPMENT

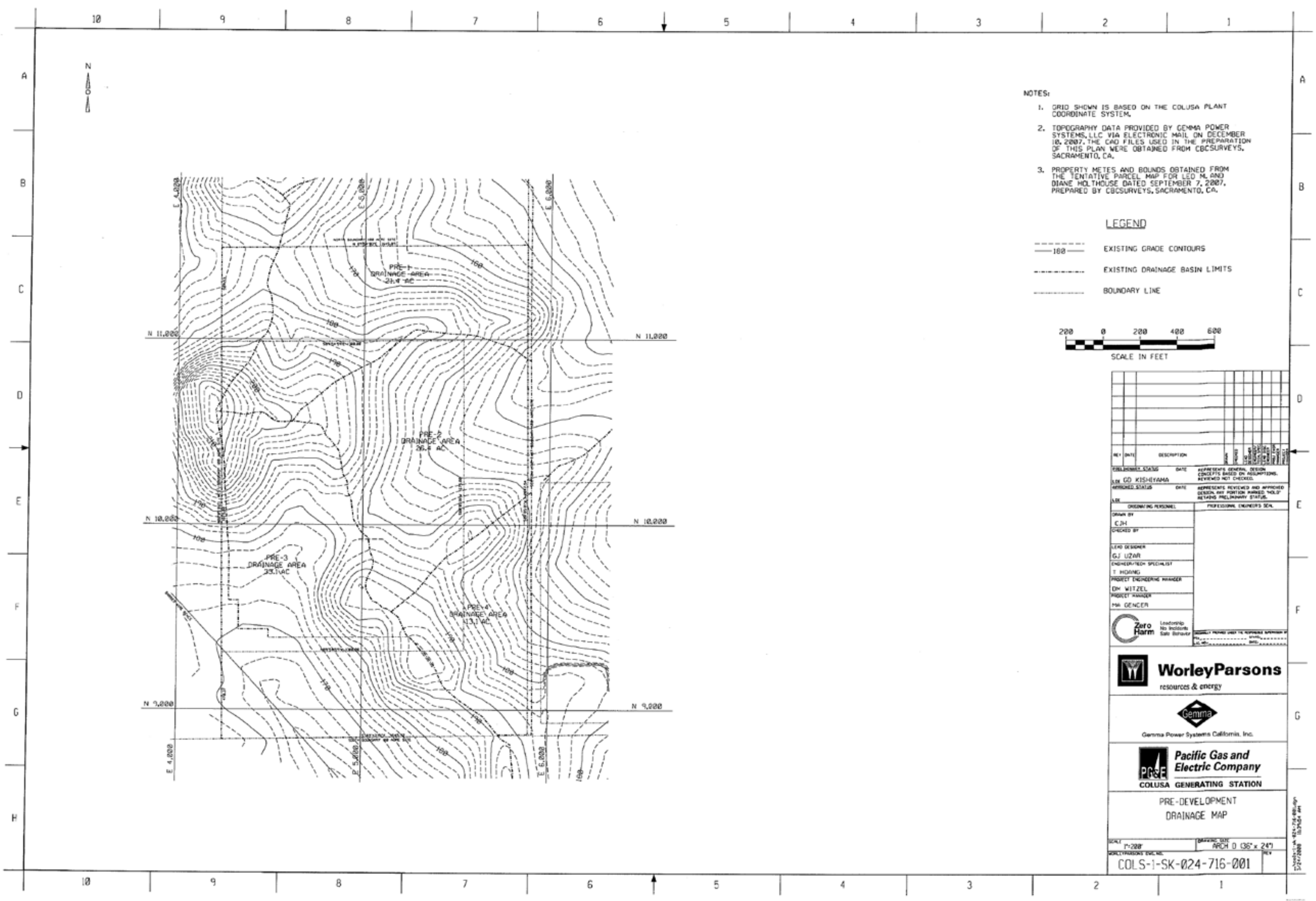


FIGURE 7 – DRAINAGE AREAS – POWER BLOCK AND LAND POST-DEVELOPMENT

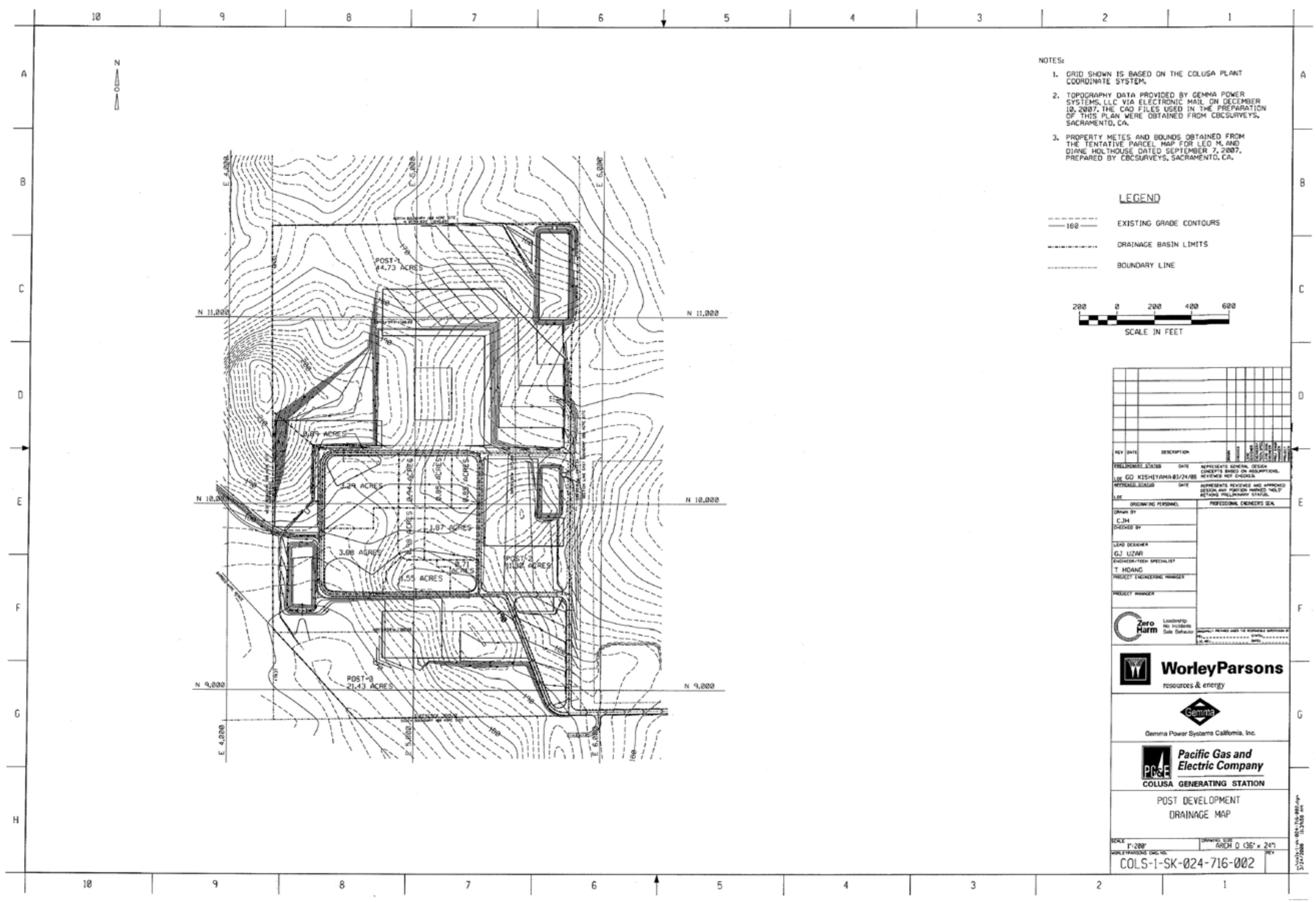


FIGURE 8A – TYPICAL LAYDOWN

Legend

- Stabilized Construction Entrance/Exit (TC-1)
- EC-7 — Geotextile, Mats, Plastic Covers, and Erosion Control Blankets (EC-7)
- WM-1 — Material Delivery and Storage (WM-1)
- WM-3 — Stockpile Management (WM-3)
- WM-5 — Solid Waste Management (WM-5)
- WM-6 — Hazardous Waste Management (WM-6)
- WM-8 — Concrete Waste Management (WM-8)
- SS — Sanitary/Septic Waste Management (WM-9)
- WM-10 — Liquid Waste Management (WM-10)
- NS-9 — Vehicle and Equipment Fueling (NS-9)
- NS-10 — Vehicle and Equipment Maintenance (NS-10)
- Fiber Rolls (SE-5) or Gravel Bags (SE-6)
- SE-7 — Street Sweeping and Vacuuming (SE-7)

Notes

1. Contractor laydown area to be determined in field.

2. Any temporary stockpiles will be underlain with plastic, surrounded with fiber rolls or gravel bags, and covered per Stockpile Management BMP (WM-3).

3. Street sweeping and vacuuming will be completed daily or whenever tracking of dirt is observed on paved areas per Street Sweeping and Vacuuming BMP (SE-7).

4. The following BMPs are to be implemented throughout the duration of the project if required:

   - Scheduling (EC-1)
   - Preservation of Existing Vegetation (EC-2)
   - Material Use (WM-2)
   - Spill Prevention and Control (WM-4)
   - Water Conservation Practices (NS-1)
   - Illicit Connection/Discharge (NS-6)
   - Wind Erosion Control (WE-1)

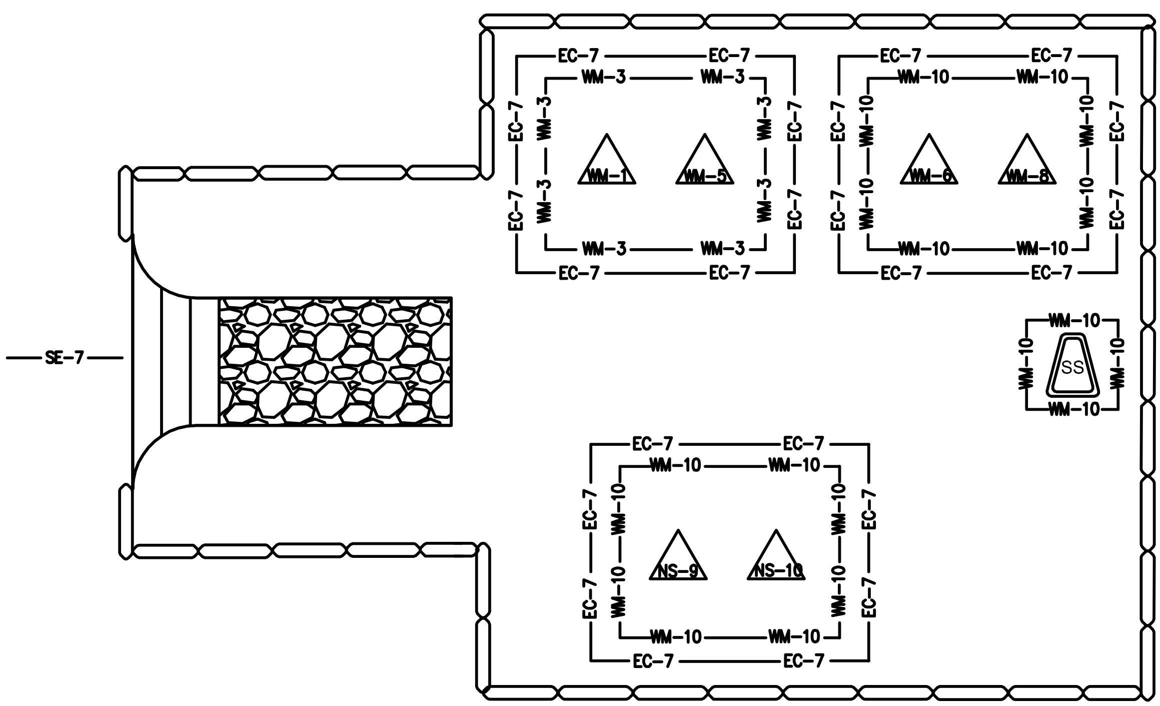
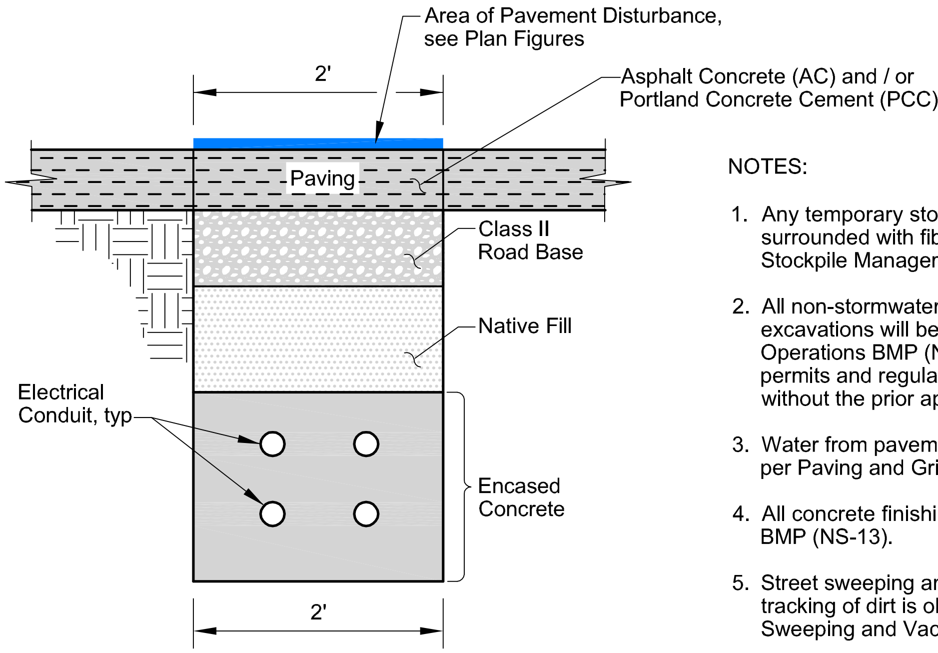


Figure 8a
Typical Laydown
Coulsa Generating Station

Coulsa Generating Station
Colusa County, California

CH2MHILL

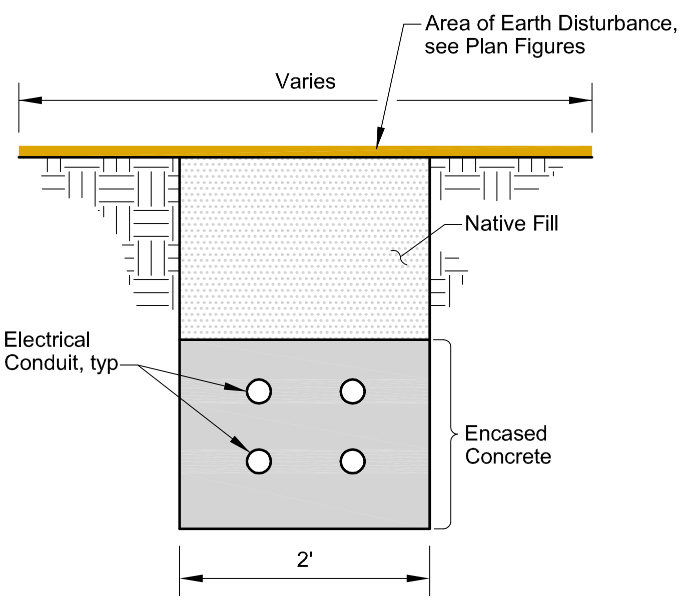
FIGURE 8B – TYPICAL TRENCHING



Paved Trenching

NOTES:

1. Any temporary stockpiles will be underlaid with plastic, surrounded with fiber rolls or gravel bags, and covered per Stockpile Management BMP (WM-3).
2. All non-stormwater and accumulated precipitation in excavations will be removed in compliance with Dewatering Operations BMP (NS-2) and with local and project specific permits and regulations. No groundwater will be discharged without the prior approval of the SCE representative.
3. Water from pavement sawcut operations will be contained per Paving and Grinding Operations BMP (NS-3).
4. All concrete finishing will comply with the Concrete Finishing BMP (NS-13).
5. Street sweeping and vacuuming will be completed when tracking of dirt is observed on paved areas per Street Sweeping and Vacuuming BMP (SE-7).
6. All storm drain inlets that could potentially receive runoff from the disturbance areas will be protected per Storm Drain Inlet BMP (SE-10). Inlets will be protected using filter fabric secured with gravel bags. Inlet protection will be removed prior to any storm event to prevent flooding.
7. All areas of disturbance will be stabilized to minimize the potential for sediment to discharge offsite.
8. All open excavations will be covered at the end of each day. Plywood will be used in non-traffic areas and steel plates will be used to cover excavations subject to traffic loading. Excavations in areas not subject to traffic will be covered and surrounded with gravel bags when feasible.
9. The following BMPs are to be implemented throughout the duration of the project:
   - Scheduling (EC-1)
   - Preservation of Existing Vegetation (EC-2)
   - Material Use (WM-2)
   - Spill Prevention and Control (WM-4)
   - Water Conservation Practices (NS-1)
   - Illicit Connection / Discharge (NS-6)
   - Wind Erosion Control (WE-1)



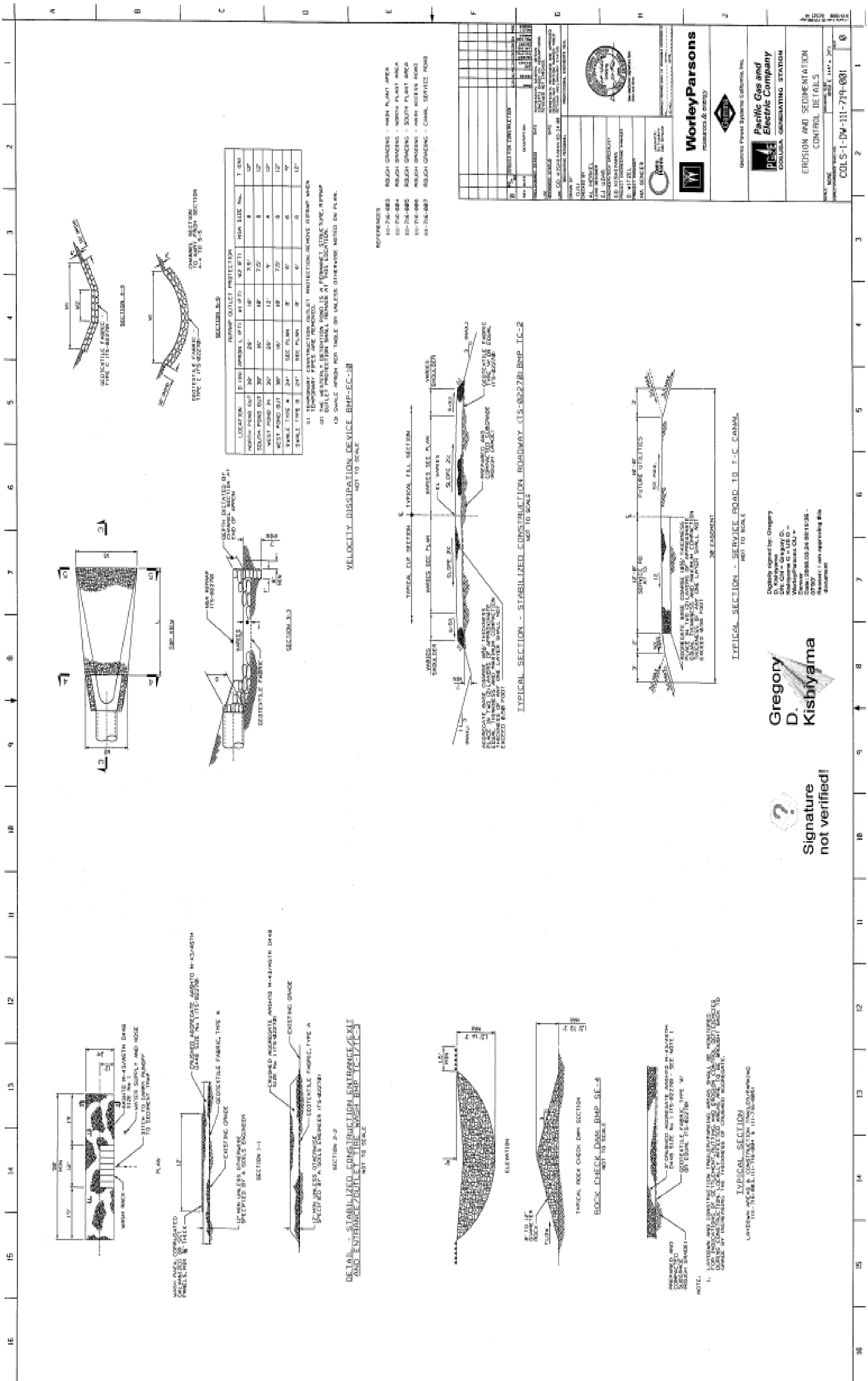
Unpaved Trenching

Figure 8b
Typical Trenching
Coulsa Generating Station

Coulsa Generating Station
Colusa County, California

CH2MHILL

FIGURE 9A – EROSION AND SEDIMENTATION CONTROL DETAILS – SHEET NO.1



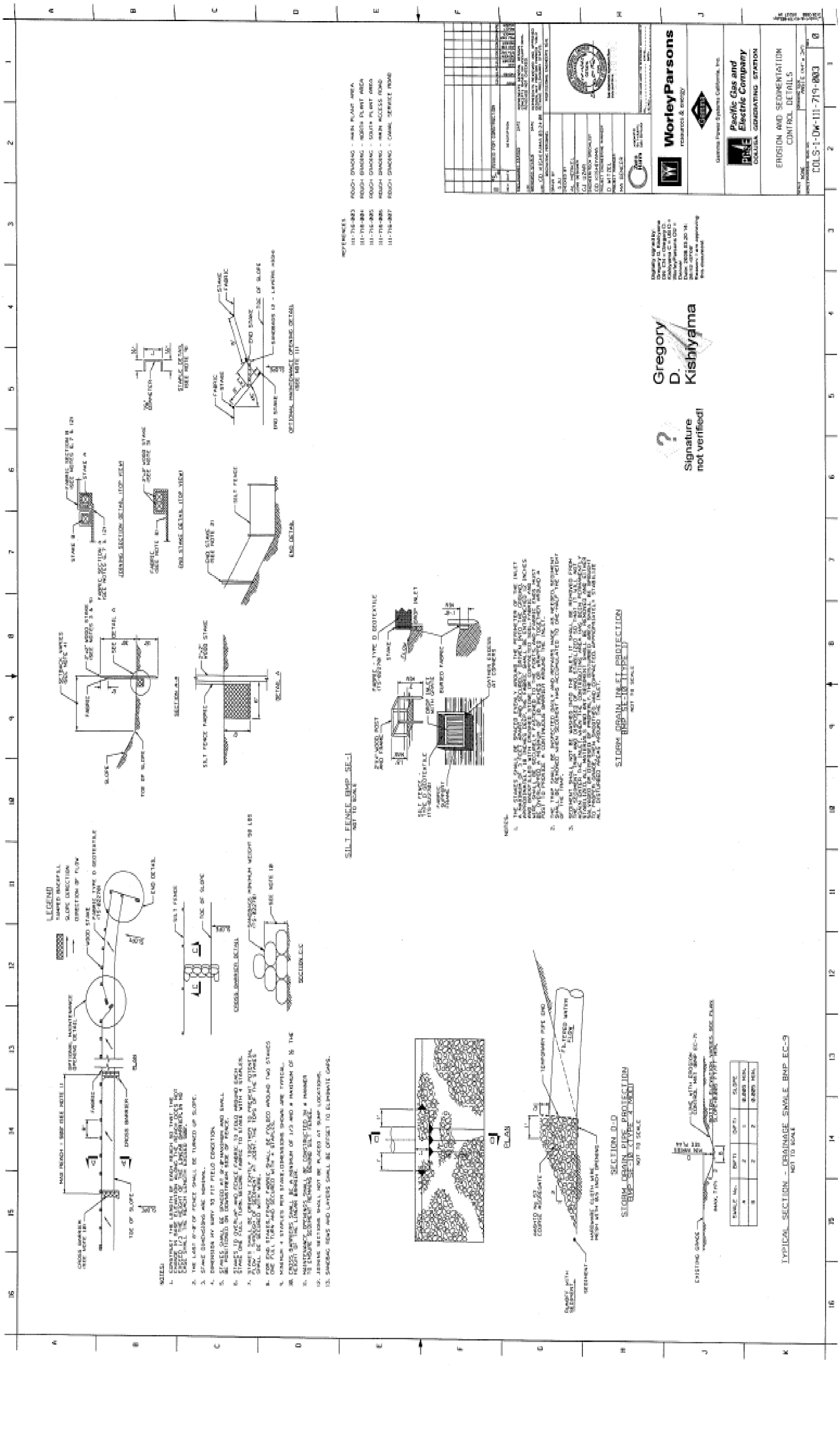

SILT FENCE BMP SE-1
STORM DRAIN INLET PROTECTION
WorleyParsons
Pacific Gas and Electric Company
EROSION AND SEDIMENTATION CONTROL DETAILS

FIGURE 9C – EROSION AND SEDIMENTATION DETAILS FOR SEDIMENT BASINS

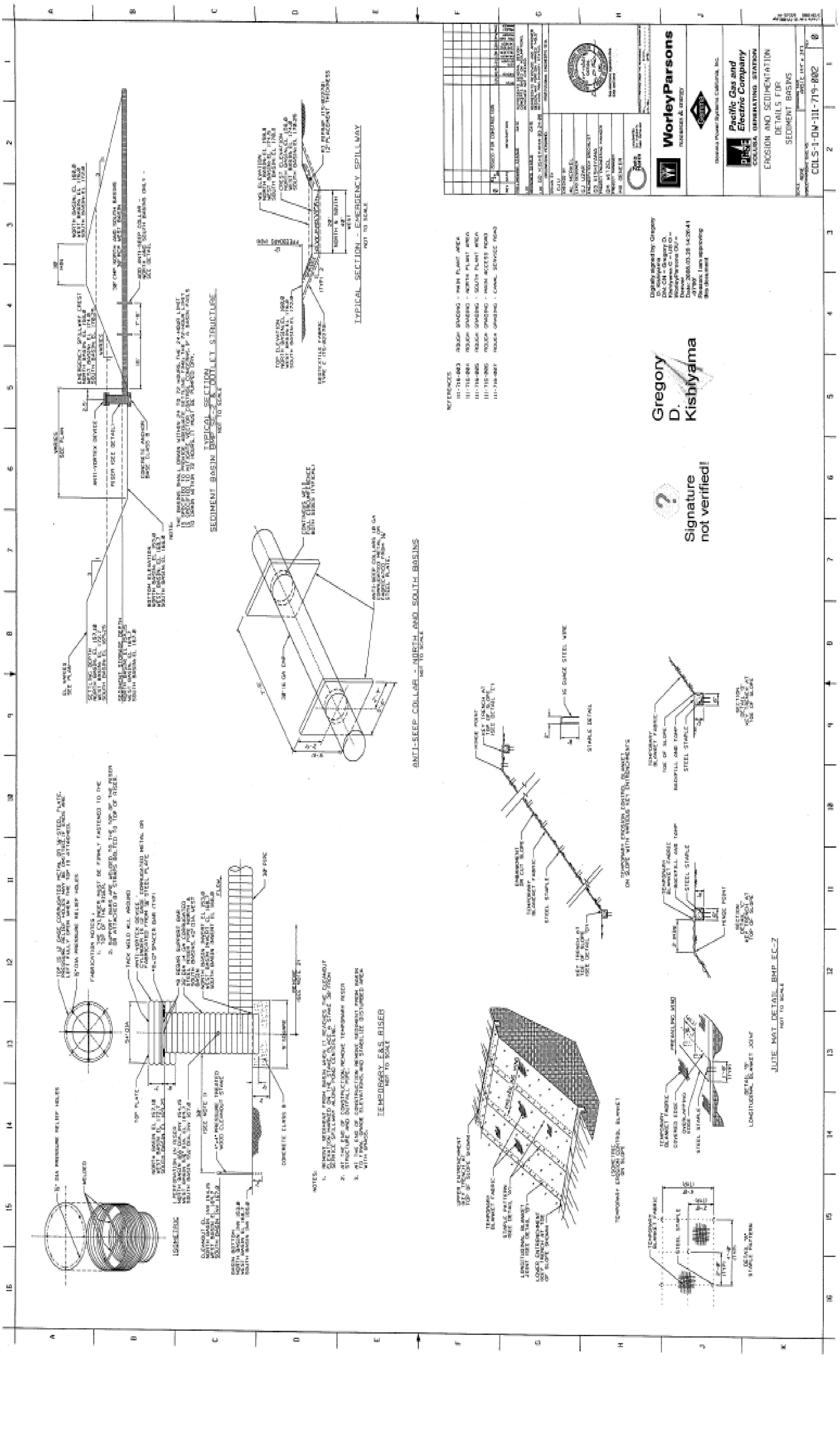


FIGURE 9D – EROSION AND SEDIMENTATION CONTROL NOTES

FIGURE 10A – ROUGH GRADING PLAN WITH BMP PLACEMENT – SHEET NO.1

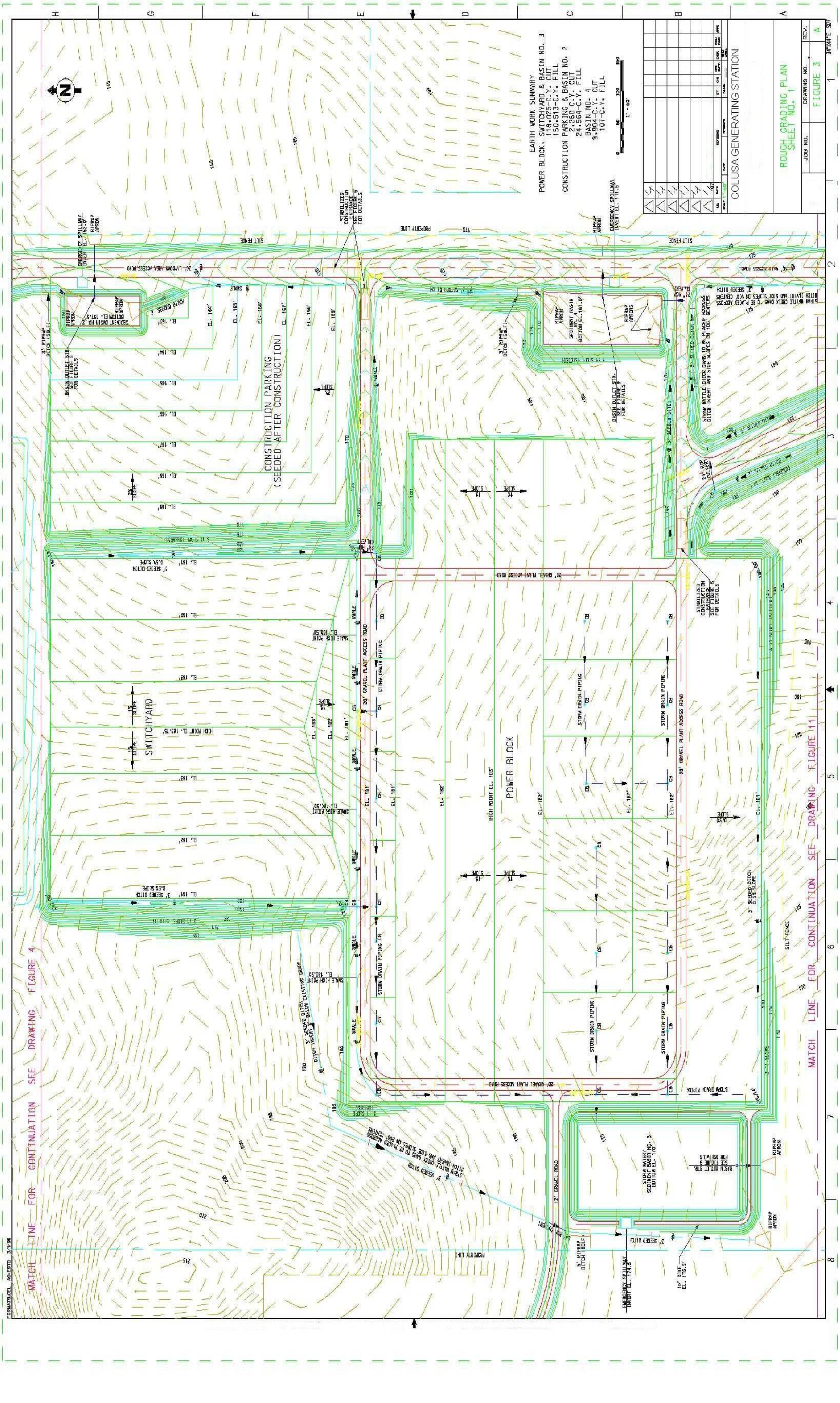


FIGURE 10B – ROUGH GRADING PLAN WITH BMP PLACEMENT – SHEET NO.2

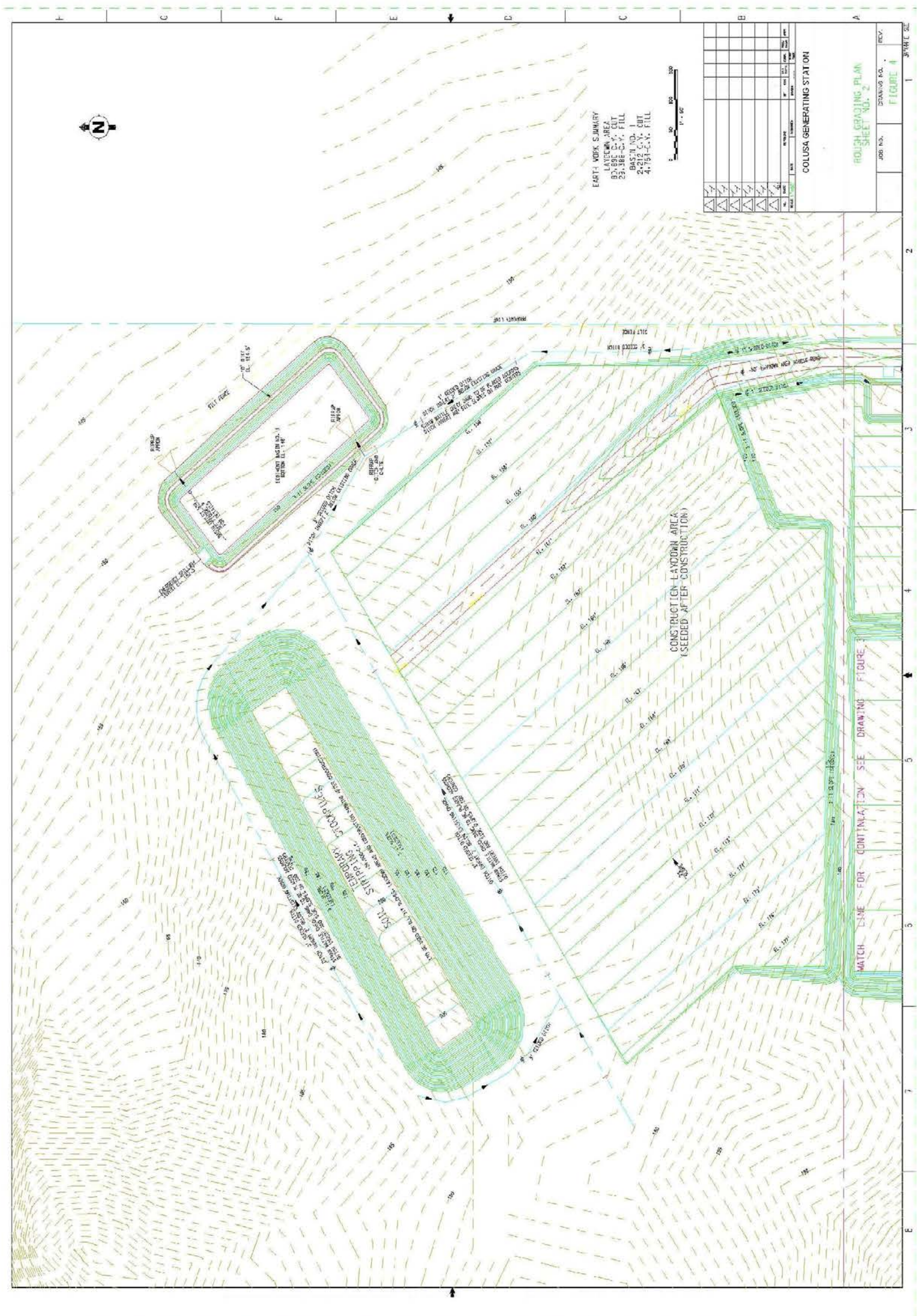
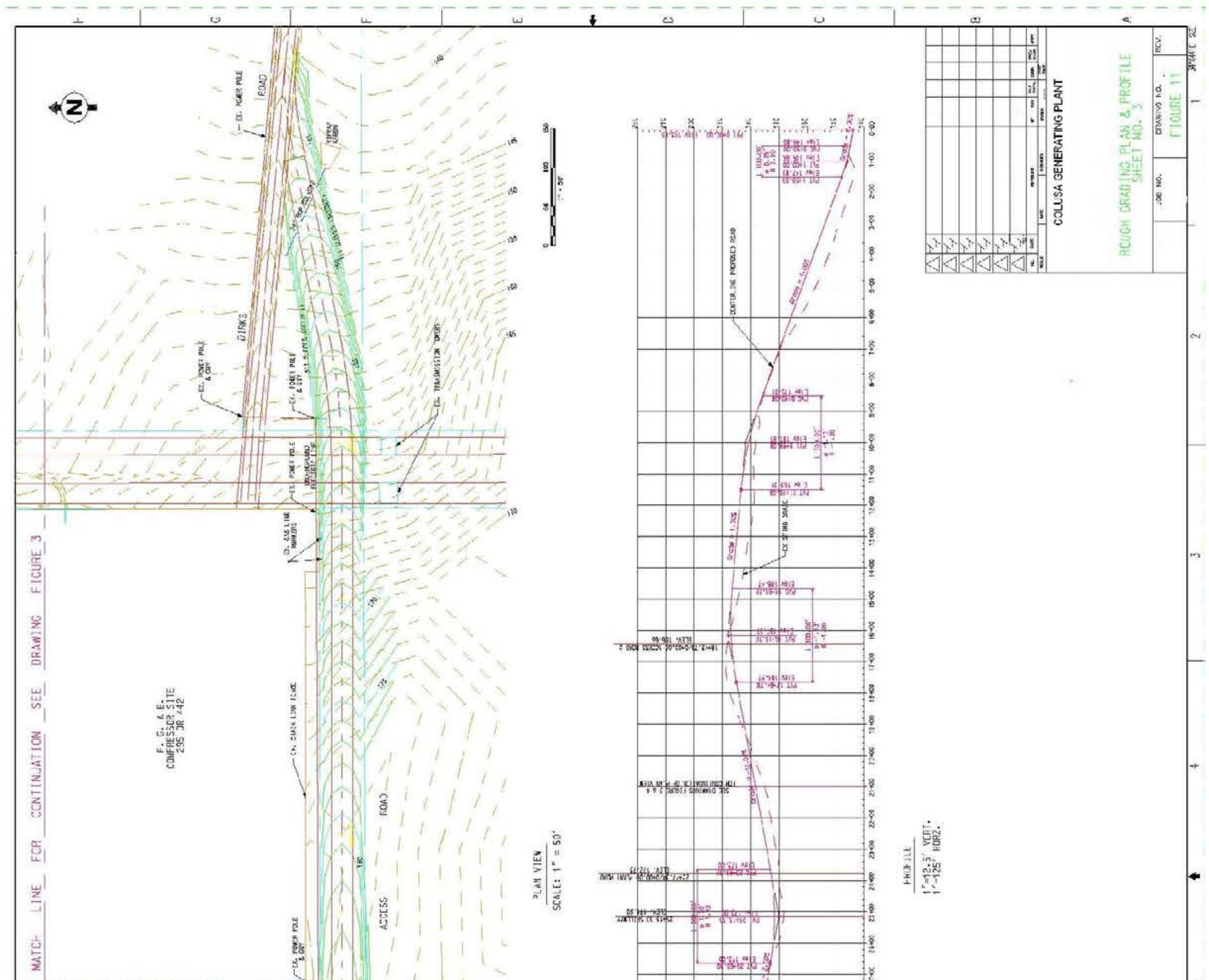


FIGURE 9C – ROUGH GRADING PLAN WITH BMP PLACEMENT– SHEET NO.3



Appendix

APPENDIX A – HYDRAULIC ANALYSIS

WorleyParsons
resources & energy

CALCULATION COVER SHEET

CLIENT	Gemma Power Systems California, Inc.
PROJECT	Colusa Generating Station
SUBJECT	Final Site Stormwater Drainage and BMP Basins
JOB NUMBER	53837001 WBS NUMBER 024
CALCULATION NO.:	COLS-1-DC-024-CE-0001 PAGE 1 OF 14

DESCRIPTION/PURPOSE

Design a stormwater drainage system and erosion and sediment control during and after construction for the Colusa Generating Station consistent with the Requirements of the California Energy Commission, Construction General Permit for NPDES requirements, and the California Stormwater Quality Association's (CASQA) Best Management Practice (BMP) Construction Handbook.

METHOD OF ANALYSIS

The Rational Method and Intensity Duration Frequency Curves for Colusa County are used to estimate runoff. The procedures described in the CASQA's BMP Construction Handbook, BMP Fact Sheets are used to design erosion and sediment control during and after construction. Haestad Methods' "FlowMaster" is used to design spillway weirs, drainage swales located within the project property, and basins' outlet pipes. Haestad Methods' "StormCAD" is used to analyze and design the stormwater drainage system located within the power block.

CODES AND STANDARDS

1. California Energy Commission, Colusa Generating Station; Final Staff Assessment; Application for Certification (06-AFC-9) Colusa County, November 2007.
2. General Construction Permit State Water Resources Control Board, Division of Water Quality, California.

REGISTERED PROFESSIONAL ENGINEER
GREGORY DEAN KISHIYAMA
EXP 12/31/07
C57376
CIVIL
STATE OF CALIFORNIA

See electronic signature fore date and time

REV	DATE	DESCRIPTION	PAGES REVISED	PAGES ADDED	PAGES DELETED	BY/DATE	REV/DATE	LDE/DATE
3								
2								
1	4/18/08	INCORPORATE CBO COMMENTS	ALL	PAGES 13 & 14	NONE	T. Hoang 4/18/08	Kishiyama 4/18/08	Kishiyama 4/18/08
0	3/24/08	ORIGINAL ISSUE	NA	NA	NA	T. Hoang 3/24/08	Kishiyama 3/24/08	Kishiyama 3/24/08

CLIENT	Gemma Power Systems California, Inc.		
PROJECT	Colusa Generating Station		
SUBJECT	Final Site Stormwater Drainage and BMP Basins		
JOB NUMBER	53837001	WBS NUMBER	024
CALCULATION NO.:	COLS-1-DC-024-CE-0001	PAGE 2 OF	14

INFORMATION SOURCES

1. California Energy Commission, Colusa Generating Station; Final Staff Assessment; Application for Certification (06-AFC-9) Colusa County, November 2007.
2. Construction General Permit for NPDES Requirements.
3. California Stormwater Quality Association's Best Management Practice (BMP) Construction Handbook, 2003/2004.
4. State Water Resources Control Board, Division of Water Quality, California.
5. Urban Drainage and Flood Control District's Urban Storm Criteria Manuals, 2006 & 2007.
6. Intensity Duration Frequency Curves for Colusa County from 1940 to 1974.
7. Intensity Duration Frequency Curves for Glenn County from 1940 to 1974.
8. Haestad Methods, Inc. "FlowMaster 2005".
9. Haestad Methods, Inc. "StormCAD v5.6".
10. WorleyParsons Drawings COLS-1-DW-111-719-001, COLS-1-DW-111-719-003, COLS-1-DW-111-719-005.
11. U.S. Department of Commerce NOAA National Weather Service's Precipitation Frequency Atlas of the Western United States Volume XI, California, 1973.
12. USDA Natural Resources Conservation Service Hydrologic Group Rating for Colusa County.
13. U.S. Department of Agriculture Soil Survey for Colusa County, California
14. City of Vacaville, Storm Water Management Plan, Design Standard

ASSUMPTIONS

Contained in body of calculation. None that need verification.

CONCLUSIONS OR RESULTS

The design of the permanent stormwater drainage system and erosion and sediment control during and after construction for the Colusa Generating Station satisfies the criteria and addresses other important factors that could affect performance. The permanent stormwater drainage system and erosion and sediment control during and after construction for the Colusa Generating Station is consistent with the requirements of the California Energy Commission (CEC), Construction General Permit for NPDES Requirements, and the California Stormwater Quality Association's (CASQA) Best Management Practice (BMP) Construction Handbook.

The CEC requires that temporary sediment basins be installed to contain sediments in the stormwater runoff from the plant and laydown areas during construction. The temporary sediment basins are to hold the required 100% runoff volume for a 2-year storm event. After construction, the West Basin shall be converted to a permanent detention basin. The detention basin shall accommodate the peak runoff from the 10-year, 24-hour storm event and empty discharge after 48 hours or less allowing sediments and on-site pollutants to settle. Site drainage system shall be designed to pass the 50-year storm event without flooding roads and the main plant.

The stormwater drainage system within the power block will effectively convey stormwater from the peak runoff from the 100-year storm event, assuring that it is self-cleaning, and yet not attaining destructive velocities in the pipes, and outfall velocities at the outlets exceeding the permissible velocity of 3.5 fps. Riprap outlet protection at the pipe outfalls and basin emergency spillways will dissipate the flows and protect these outlets from scour of the soil. Erosion and sediment control during and after construction will be satisfactory to pass both 10-year and 100-year storm events, respectively. Also, roads and the main plant will not be flooded during the 50-year storm event since the stormwater drainage system can convey flows from the 100-year storm event.

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3. Intensity Duration Frequency Curves
4. Proposed Plant Area General Arrangement
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8. Drainage Areas - Land Pre-development
9. Runoff Calculations – Power Block
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11. Runoff Calculations – Land Post Development
12. Catch Basin, Manhole, and Pipe Schedule
13. StormCAD Calculation Results Summary
14. Swale Calculations
15. Weir Calculations
16. Standard 600-10C Grate
17. North Basin Calculations
18. South Basin Calculations
19. West Basin Calculations
20. Permissible Velocities for Earth-Lined Channels

STORMWATER DRAINAGE DESIGN CRITERIA

1. Stormwater Management:

   A. Design a permanent stormwater drainage system and erosion and sediment control during and after construction for the Colusa Generating Station consistent with the requirements of the California Energy Commission (CEC, Reference 1), Construction General Permit for NPDES Requirements (Reference 2), and the California Stormwater Quality Association's (CASQA) Best Management Practice (BMP) Construction Handbook (Reference 3). The CEC requires that temporary sediment basins be installed to contain sediments in the stormwater runoff from the plant and laydown areas during construction. The temporary sediment basins are to hold the required 100% runoff volume for a 2-year storm event. After construction, the West Basin shall be converted to a permanent detention basin. The detention basin shall accommodate the peak runoff from the 10-year, 24-hour storm event and empty discharge after 48 hours or less allowing sediments and on-site pollutants to settle. Site drainage system shall be designed to pass the 50-year storm event without flooding roads and the main plant. The CASQA's BMP Construction Handbook and BMP Fact Sheets (Attachment 1) are used to design erosion and sediment control during and after construction. The storm drainage system within the power block, including smooth lined polyethylene pipes, catch basins, and manholes, is designed to convey the 100-year storm event. The pond located west of the power block (West Basin) is designed to be a sediment basin to control the 2-year storm event during construction. It will then be converted into a detention basin after construction, which is designed for a 10-year, 24-hour storm event. The other two ponds (North and South Basins) are designed to be temporary sediment basins, which should control the 2-year storm event, during construction. Spillway weirs (North and South Basins) and drainage swales are designed to pass the 10-year storm event. The West Basin spillway weir is designed to pass the 100-year storm event.

   B. Specific guidelines are provided by the Rational Method to estimate the peak runoff flows of the power block, land pre-development, and land post-development which consists of the power block area and areas outside of the power block. The Rational Method is expressed by equations and tables, which are presented in the Stormwater Runoff section and in Attachment 2, to calculate the maximum rate of runoff with known runoff coefficient, known average rainfall intensity, and known drainage area.

   C. Average rainfall intensity of each storm event can be read off of the Intensity Duration Frequency Curves for Colusa County from 1940 to 1974 (Reference 6, Attachment 3) with known time of concentration. Times of concentration shall be determined by equation $T_c = T_i + T_t$, which will be explained in later sections, where runoff coefficients need to be obtained from Table RO-5, Type C and D NRCS Hydrologic Soil Groups (Attachment 2) along with other criteria described below, which can be also found in Attachment 2.

      1) Power Block:
         - Percentage Imperviousness = 90% (Table RO-3)
         - Conveyance Coefficient = 20 (Table RO-2)

      2) Land Pre-Development:
         - Percentage Imperviousness = 45% (Table RO-3)
         - Conveyance Coefficient = 7 (Table RO-2)

      3) Land Post-Development:
         - Percentage Imperviousness = 45% (Table RO-3)
         - Conveyance Coefficient = 7 (Table RO-2)

2. Sediment and Detention Basins:

   A. Three sediment basins are designed by BMP SE-2 Option 4 (Reference 3) and as follows:

1) Basin Components:

- Capture 100% of annual runoff volume based on the 2-year storm event.
- Energy dissipation devices where outlet pipes shall be designed for the 10-year storm event and by BMP EC-10 (Reference 3).
- Emergency spillway

2) Flow control at the outlet of the basin is designed by equation Eq.3 in BMP SE-2 (Attachment 1) with a drawndown time of 40 hours and orifice coefficient of 0.6.

3) Basin side slope is designed to 3:1 (H:V).

4) Sediment basin settling volume (runoff volume) is designed by using the rainfall value of 2.50 inches (Reference 11, 2-Year 24-Hour Rainfall)

5) Emergency Spillway:

- An emergency spillway shall be provided, consisting of an open channel constructed on top of the embankment.
- The spillway shall be designed to carry the peak rate of runoff expected from a 10-year, 24-hour and 100-year, 24-hour design storms for North & South and West Basins, respectively.
- The spillway shall be designed to provide 1-foot of freeboard during the 10-year and 100-year storm event.

6) The basins shall discharge to a stabilized drainage way protected from erosion. Attachment 20 shows the table of Permissible Velocities for Earth-Lined Channels (Reference 14) that can be utilized for the site's silty clay soil condition (Reference 13).

B. The detention basin (West Basin) is designed to detain excess flows by BMP SE-2 Option 4 (Reference 3) and as follows:

1) Detention basin settling volume is designed by comparing the peak runoff of the overall land post-development based on the 10-year design storm to the sediment basin's volume. The larger volume will govern the design.

3. Drainage Swale:

Following the CASQA Best Management Practice (BMP) Construction Handbook (Reference 3), BMP Fact Sheet EC-9 (Attachment 1), drainage swales are designed as follows:

- No more than 5 acres may drain to a temporary drainage swale.
- Swale bottom width should be at least 2 feet.
- Depth of the swale should be at least 12 inches.
- Side slope should be 2:1 (H:V) or flatter.
- Design swale for the 10-year storm event.

4. Erosion and Sediment Control Best Management Practices (BMPs):

The following best management practices (BMPs) are to be utilized at this site: velocity dissipation devices; drainage swale. These BMPs shall be implemented following the CASQA Best Management Practice (BMP) Construction Handbook (Reference 3) Fact Sheets specific to that BMP (Attachment 1).

SITE DATA

1. Location:

The site of the proposed Colusa Generating Station is located in the unincorporated portion of Colusa County, California (Reference 1). The proposed drainage for the plant area will envelope approximately 100 acres of the property. A general arrangement of the proposed plant area is shown in Attachment 4. The final site stormwater drainage system arrangement is shown in Attachment 5.

2. Soils:

The U.S. Department of Agriculture Soil Survey for Colusa County, California (Reference 13, Attachment 6) indicated that surface soils at the site consist chiefly of clays, silty clays, and clayey loams, which are classified as hydrologic Group D soils series. These soils have high runoff potential.

STORMWATER RUNOFF

1. Rational Method:

The Rational Method is described as follows:

$$Q = CIA$$

Where:

Q = the maximum rate of runoff if cubic feet per second (cfs)

C = a runoff coefficient that is the average rate rainfall depth over a given duration for that area

I = average intensity of rainfall in inches per hour for a duration equal to the time of concentration, T_c

A = drainage area in acres

2. Time of Concentration, T_c:

$$T_c = T_i + T_t$$

Where:

T_c = time of concentration in minutes (min)

T_i = overland flow time in minutes (min)

T_t = channel flow time in minutes (min)

3. Overland Flow Time, Ti:

$$T_i = \frac{0.395(1.1 - C)\sqrt{L}}{S^{0.33}} \qquad \text{(Reference 5)}$$

Where:

T_i = overland flow time in minutes (min)

C = runoff coefficient for 2-year or 10-year, or 100-year event

L = length of overland flow in feet (ft)

S = average overland slope (ft/ft)

The runoff coefficient of each design storm event is read off Table RO-5 Type C and D NRCS Hydrologic Soil Groups (Attachment 2) after percentage imperviousness is selected from Table RO-3 (Attachment 2).

4. Channel Flow Time, T_t:

   From equation:

   $$V = C_v S^{0.5}$$

   Where:

   V = drainage velocity in feet per second (ft/sec)

   C_v = conveyance coefficient from Table RO-2 (Attachment 2)

   S = channelized slope (ft/ft)

   The channelized flow time can be calculated as follows:

   $$T_t = \frac{L}{60Cv\sqrt{S}}$$ (Reference 5)

   Where:

   T_t = channelized flow time in minutes (min)

   L = length of overland flow in feet (ft)

5. First Design Point Time of Concentration:

   The site is assumed to be an urbanized area so a more conservative design can be achieved. The equation of:

   $$T_c = \frac{L}{180} + 10$$ (Reference 5)

   Where:

   T_c = maximum time of concentration at the first design point in an urban watershed in minutes

   L = sum of overland and channel flow length in feet (ft)

   Can be compared to the initial time of concentration. The smaller time of concentration will govern the design.

6. Rainfall Intensity, I:

   After time of concentration is determined, rainfall intensity is read off of the Intensity Duration Frequency Curves for Glenn County from 1940 to 1974 (Reference 7, Attachment 3). Attachment 3 also shows the Intensity Duration Frequency Curves for Colusa County from 1940 to 1974 (Reference 6), but is not utilized since the project site is at the approximately 180-feet-elevation. A better design will come off of the curves for Glenn County since they are prepared for sites that are at elevation of 770 feet.

7. Drainage Area, A:

   Drainage areas are depicted in the Attachments 7 and 8 for each individual inlet and scenario. This data is presented in the Runoff Calculations (Attachment 9) for the power block area (16.6 acres), Attachment 10 for the land pre-development area (100 acres), and Attachment 11 for the land post-development area (77.4 acres). 6 acres of the 100-acres-parcel is excluded from the calculations since it remains undisturbed and does not affect the post-development conditions.

8. Peak Runoff Calculations:

   Peak runoff for the individual drainage sub areas to the individual basin inlets is calculated for 2-year, 10-year, and 100-year storm frequencies. This data is presented in Attachment 9 for the power block drainage area. Attachment 10 presents the runoff calculations for the land pre-development drainage area while Attachment 11 shows the calculations for the land post-development drainage area.

9. Pipe Flow Rate:

   Pipe flow rate is calculated using the StormCAD software (Reference 9). The software analysis accounts for the total area and runoff that is contributing to each pipe and inlet. This data is presented on the Runoff Calculations in Attachment 9 for the power block area. The catch basin, manhole, and pipe schedule for the power block is shown in Attachment 12. The calculation results summary from StormCAD is shown in Attachment 13.

   The minimum full flow velocity for the power block's stormwater drainage system is approximately 2.69 ft/sec while the maximum full flow velocity is approximately 12.61 ft/sec. This meets the requirement of a minimum of 2.0 ft/sec and a maximum of 15.0 ft/sec.

DRAINAGE SWALES

Two type of drainage swales, Type A and Type B (Attachment 14), are designed following CASQA Fact Sheet EC-9 (Reference 3, Attachment 1). These jute net lined drainage swales will have a minimum slope of 0.005 ft/ft, side slope of 2:1 (H:V), and bottom width of 2 ft. At full flow capacity, Type A swale can carry 7.62 cfs while Type B swale can carry 33.52 cfs, which can carry the 10-year storm event.

SPILLWAY WEIRS

Broad crested weirs are utilized for all basins and are designed to meet the previous described criteria. FlowMaster (Reference 8) results for these weirs are presented in Attachment 15. At full flow capacity, the North & South and the West Basin weirs can pass the 10-year and 100-year storm events, respectively. Also, their outfall velocities are not exceeding the permissible velocity shown in Attachment 20, which is 3.5 fps.

INLET GRATE CAPACITY

Check the capacity of the storm drain inlets for ponding conditions. Assume a maximum allowable depth of 0.5 feet (6") over the grate for the design flows calculated in Attachments 9.

The grate specified for this project is Caltrans Type 600-10C.

$$Q = CLH^{3/2}$$

where:

Q = flow through the grate in cubic feet per second. (cfs)
C = coefficient of discharge, which has a value of 3.3
L = horizontal crest "net" length of the grate in feet
H = depth in feet of water over the grate

The Standard 600-10C grate is comprised of 6 openings, 5 ¾" long on the two long sides, and 9 openings, 1 9/16" long on the two short sides (Attachment 16). That arrangement results in a net length as follows:

$$L = (6 * 5\tfrac{3}{4}" * 2) + (9 * 1\ 9/16" * 2) = 8.11 \text{ ft}$$

Then Q is computed as:

$$Q = 3.3 * 8.11 * .5^{3/2} = \mathbf{9.46\ cfs}$$

Check the capacity of the grate assuming ***orifice flow*** for storm drain inlets. The net open area of the grate is used as the orifice area, and the discharge is computed using the orifice equation, where:

$$Q = CA\sqrt{2gh}$$

and:

Q = flow through the grate in cubic feet per second. (cfs)
C = coefficient of Discharge, which has a value of 0.60.
A = net area of the grate opening in square feet. (ft^2)
G = gravitation acceleration, which has a constant value of 32.2 feet per second per second (ft/sec^2).
h = depth in feet of water over the grate (0.5 ft)

The Standard 600-10C grate is comprised of 50 openings 1 9/16" by 5 ¾" and 8 openings 1 9/16" by 2 6/7". Thus, the net area is as follows:

$$A = (50 * 1\ 9/16" * 5\ 3/4") + (8 * 1\ 9/16" * 2\ 6/7") = 3.39\ ft^2$$

Then Q is computed as:

$$0.60 * 3.39 * \sqrt{2 * 32.2 * 0.5} = \mathbf{11.54\ cfs}$$

Conclusion: Weir flow controls the design of inlet grate capacity. All inlet grates within the power block should be fine using the Caltrans Type 600-10C grate in any storm event (100-year flow equals 6.26 cfs for Inlet I-8) since none of their runoff exceeds 9.46 cfs.

SEDIMENT AND DETENTION BASINS

The temporary North and South Basins will be utilized as sediment basins during construction and are designed to pass the 2-year storm event. The West Basin will be also utilized as a sediment basin, but will be modified and converted into a permanent detention basin after construction. This detention basin is designed to control the 10-year storm event. The stormwater drainage system within the power block is designed to pass the 100-year storm event.

These basins are designed to meet the criteria of the CASQA Best Management Practice (BMP) Construction Handbook, BMP SE-2 Option 4 (Reference 3). The outfall velocities are analyzed to ensure the outlets are being protected from scour of the soil. Therefore, Velocity Dissipation Devices are taken into consideration and will be discussed in the next section. The velocities after dissipation are also being checked using Haestad Methods' "FlowMaster" to ensure that these velocities won't exceed the permissible velocity shown in Attachment 20. Both Broad Crested Weir and Channel flows are analyzed for velocity, and the more conservative approach controls the design. Attachment 17, Attachment 18, and Attachment 19 present calculation worksheets and summary of results for these basins as follows:

A. North Basin:

- Bottom dimensions: 460 ft x 150 ft x 5 ft deep
- Side slope: 3:1 (H:V)
- Total required volume: 310,731 ft^3
- Dead settlement volume: 81,785 ft^3

- Live water volume: 232,654 ft^3
- Basin capacity: 314,359 ft^3
- Required orifice diameter: 8 ½"
- Outlet pipe: 30 in (corrugate metal pipe)
- Velocity after energy dissipated: 2.36 fps (less than 3.5 fps)

B. South Basin:

- Bottom dimensions: 250 ft x 100 ft x 4.25 ft deep
- Side slope: 3:1 (H:V)
- Total required volume: 80,657 ft^3
- Dead settlement volume: 26,061 ft^3
- Live water volume: 66,678 ft^3
- Basin capacity: 92,712 ft^3
- Required orifice diameter: 5 ¼"
- Outlet pipe: 30 in (corrugate metal pipe)
- Velocity after energy dissipated: 2.23 fps (less than 3.5 fps)

C. West Basin:

- Bottom dimensions: 310 ft x 100 ft x 5 ft deep
- Side slope: 3:1 (H:V)
- Total required volume: 127,712 ft^3
- Dead settlement volume: 32,240 ft^3
- Live water volume: 112,158 ft^3
- Basin capacity: 144,330 ft^3
- Required orifice diameter: 5 ¾"
- Outlet pipe: 30 in (reinforced concrete pipe)
- Velocity after energy dissipated: 2.48 fps (less than 3.5 fps)
- Design volume for detention purpose per 10-year storm event: 11,813 ft^3
- Inlet Pipe: 36 in (smooth lined polyethylene pipe)
- Velocity after energy dissipated: 2.78 fps (less than 3.5 fps)

EROSION AND SEDIMENT CONTROL BEST MANAGEMENT PRACTICES

The California Stormwater Quality Association's (CASQA) Best Management Practice (BMP) Construction Handbook (Reference 3) is used to design and implement best management practices for erosion and sediment control on the site. The Fact Sheets provided by CASQA describing each of the following BMPs are shown in Attachment 1.

1. Velocity Dissipation Devices (EC-10)

Velocity dissipation devices in the form of riprap aprons are to be provided at the outlet of all systems into their respective basins. The location of the riprap aprons are shown on Attachment 7. The riprap aprons are sized using the chart shown on page 4 of Fact Sheet EC-10. Filter fabric will be provided under all riprap aprons. The riprap size is NSA size No. R-4, which is capable of withstanding 9 ft/sec, which is greater than the actual velocities.

Riprap Outlet Protection Sizing

Location	Outlet Size(1) (ft)	Discharge(2) (cfs)	Apron Length (ft)	Apron Width 1(3) (ft)	Apron Width 2 (ft)	Riprap D_{50} (inches)	Thickness(4) (inches)
North Basin	30(5)	53	26	10	7.5	8	12
South Basin	30(5)	39.55	26	10	7.5	8	12
West Basin	30(6)	31.5	16	10	7.5	8	12
West Basin (Inlet)	36(7)	40.87	26	12	9	8	12

Notes:

(1) No 30-inch diameter is available in the chart, so the 24-inch diameter discharge rates are utilized for a more conservative approach.
(2) Values are obtained from Attachment 9, 10, and 11.
(3) Apron Width 1 is equal to four times the outlet size. See CASQA Fact Sheet EC-10, page 4.
(4) Laying thickness is equal to 1.5 times maximum riprap rock size.
(5) Corrugate metal pipe per 10-year design storm.
(6) Reinforced concrete pipe per 100-year design storm.
(7) Smooth lined polyethylene pipe per 100-design storm.

2. Drainage Swales (EC-9)

Some of the drainage swales designed as temporary construction drainage will be kept for final drainage. Refer to Attachment for details. Permanent swales are designed to carry the 10-year storm event flows.

CONCLUSIONS

The design of the permanent stormwater drainage system and erosion and sediment control during and after construction for the Colusa Generating Station satisfies the criteria and addresses other important factors that could affect performance. The permanent stormwater drainage system and erosion and sediment control during and after construction for the Colusa Generating Station is consistent with the requirements of the California Energy Commission (CEC), Construction General Permit for NPDES Requirements, and the California Stormwater Quality Association's (CASQA) Best Management Practice (BMP) Construction Handbook.

The CEC requires that temporary sediment basins be installed to contain sediments in the stormwater runoff from the plant and laydown areas during construction. The temporary sediment basins are to hold the required 100% runoff volume for a 2-year storm event. After construction, the West Basin shall be converted to a permanent detention basin. The detention basin shall accommodate the peak runoff from the 10-year, 24-hour storm event and empty discharge after 48 hours or less allowing sediments and on-site pollutants to settle. Site drainage system shall be designed to pass the 50-year storm event without flooding roads and the main plant.

The stormwater drainage system within the power block will effectively convey stormwater from the peak runoff from the 100-year storm event, assuring that it is self-cleaning, and yet not attaining destructive velocities in the pipes, and outfall velocities at the outlets exceeding the permissible velocity of 3.5 fps. Riprap outlet protection at the pipe outfalls and basin emergency spillways will dissipate the flows and protect these outlets from scour of the soil. Erosion and sediment control during and after construction will be satisfactory to pass both 10-year and 100-year storm events, respectively. Also, roads and the main plant will not be flooded during the 50-year storm event since the stormwater drainage system can convey flows from the 100-year storm event.

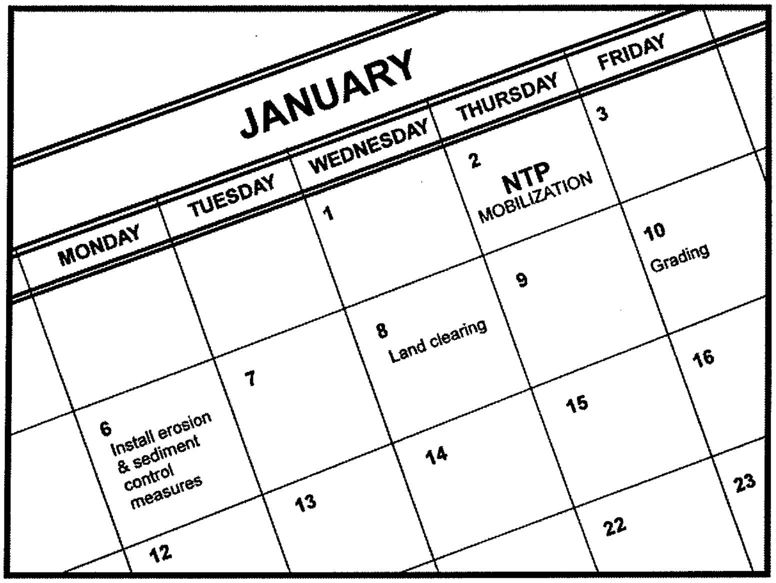
END

ATTACHMENT 1

COLUSA GENERATING STATION
COLS-1-DC-024-0001

BMPs

Scheduling EC-1



Objectives

EC	Erosion Control	☑
SE	Sediment Control	☒
TR	Tracking Control	☒
WE	Wind Erosion Control	☒
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Scheduling is the development of a written plan that includes sequencing of construction activities and the implementation of BMPs such as erosion control and sediment control while taking local climate (rainfall, wind, etc.) into consideration. The purpose is to reduce the amount and duration of soil exposed to erosion by wind, rain, runoff, and vehicle tracking, and to perform the construction activities and control practices in accordance with the planned schedule.

Suitable Applications

Proper sequencing of construction activities to reduce erosion potential should be incorporated into the schedule of every construction project especially during rainy season. Use of other, more costly yet less effective, erosion and sediment control BMPs may often be reduced through proper construction sequencing.

Limitations

- Environmental constraints such as nesting season prohibitions reduce the full capabilities of this BMP.

Implementation

- Avoid rainy periods. Schedule major grading operations during dry months when practical. Allow enough time before rainfall begins to stabilize the soil with vegetation or physical means or to install sediment trapping devices.

- Plan the project and develop a schedule showing each phase of construction. Clearly show how the rainy season relates to soil disturbing and re-stabilization activities. Incorporate the construction schedule into the SWPPP.

- Include on the schedule, details on the rainy season implementation and deployment of:
  - Erosion control BMPs
  - Sediment control BMPs
  - Tracking control BMPs
  - Wind erosion control BMPs
  - Non-stormwater BMPs
  - Waste management and materials pollution control BMPs
- Include dates for activities that may require non-stormwater discharges such as dewatering, sawcutting, grinding, drilling, boring, crushing, blasting, painting, hydro-demolition, mortar mixing, pavement cleaning, etc.
- Work out the sequencing and timetable for the start and completion of each item such as site clearing and grubbing, grading, excavation, paving, foundation pouring utilities installation, etc., to minimize the active construction area during the rainy season.
  - Sequence trenching activities so that most open portions are closed before new trenching begins.
  - Incorporate staged seeding and re-vegetation of graded slopes as work progresses.
  - Schedule establishment of permanent vegetation during appropriate planting time for specified vegetation.
- Non-active areas should be stabilized as soon as practical after the cessation of soil disturbing activities or one day prior to the onset of precipitation.
- Monitor the weather forecast for rainfall.
- When rainfall is predicted, adjust the construction schedule to allow the implementation of soil stabilization and sediment treatment controls on all disturbed areas prior to the onset of rain.
- Be prepared year round to deploy erosion control and sediment control BMPs. Erosion may be caused during dry seasons by un-seasonal rainfall, wind, and vehicle tracking. Keep the site stabilized year round, and retain and maintain rainy season sediment trapping devices in operational condition.
- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.

Costs

Construction scheduling to reduce erosion may increase other construction costs due to reduced economies of scale in performing site grading. The cost effectiveness of scheduling techniques should be compared with the other less effective erosion and sedimentation controls to achieve a cost effective balance.

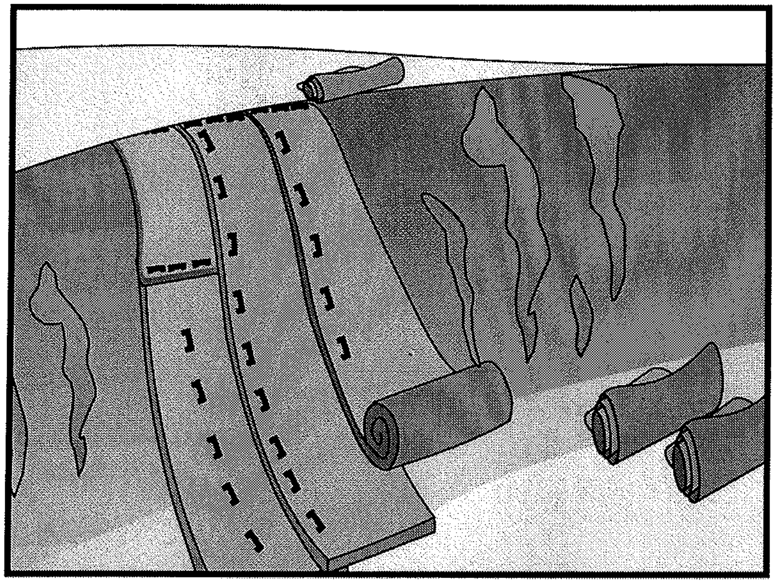
Inspection and Maintenance

- Verify that work is progressing in accordance with the schedule. If progress deviates, take corrective actions.
- Amend the schedule when changes are warranted.
- Amend the schedule prior to the rainy season to show updated information on the deployment and implementation of construction site BMPs.

References

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management for Construction Activities Developing Pollution Prevention Plans and Best Management Practices (EPA 832-R-92-005), U.S. Environmental Protection Agency, Office of Water, September 1992.



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	3
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

EC-5 Soil Binders

EC-6 Straw Mulch

EC-8 Wood Mulching

Description and Purpose

Mattings of natural materials are used to cover the soil surface to reduce erosion from rainfall impact, hold soil in place, and absorb and hold moisture near the soil surface. Additionally, matting may be used to stabilize soils until vegetation is established.

Suitable Applications

Mattings are commonly applied on short, steep slopes where erosion hazard is high and vegetation will be slow to establish. Mattings are also used on stream banks where moving water at velocities between 3 ft/s and 6 ft/s are likely to wash out new vegetation, and in areas where the soil surface is disturbed and where existing vegetation has been removed. Matting may also be used when seeding cannot occur (e.g., late season construction and/or the arrival of an early rain season). Erosion control matting should be considered when the soils are fine grained and potentially erosive. These measures should be considered in the following situations.

- Steep slopes, generally steeper than 3:1 (H:V)
- Slopes where the erosion potential is high
- Slopes and disturbed soils where mulch must be anchored
- Disturbed areas where plants are slow to develop
- Channels with flows exceeding 3.3 ft/s

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- Channels to be vegetated
- Stockpiles
- Slopes adjacent to water bodies of Environmentally Sensitive Areas (ESAs)

Limitations

- Properly installed mattings provide excellent erosion control but do so at relatively high cost. This high cost typically limits the use of mattings to areas of concentrated channel flow and steep slopes.
- Mattings are more costly than other BMP practices, limiting their use to areas where other BMPs are ineffective (e.g. channels, steep slopes).
- Installation is critical and requires experienced contractors. The contractor should install the matting material in such a manner that continuous contact between the material and the soil occurs.
- Geotextiles and Mats may delay seed germination, due to reduction in soil temperature.
- Blankets and mats are generally not suitable for excessively rocky sites or areas where the final vegetation will be mowed (since staples and netting can catch in mowers).
- Blankets and mats must be removed and disposed of prior to application of permanent soil stabilization measures.
- Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
- Plastic results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- The use of plastic should be limited to covering stockpiles or very small graded areas for short periods of time (such as through one imminent storm event) until alternative measures, such as seeding and mulching, may be installed.
- Geotextiles, mats, plastic covers, and erosion control covers have maximum flow rate limitations; consult the manufacturer for proper selection.
- Not suitable for areas that have heavy foot traffic (tripping hazard) – e.g., pad areas around buildings under construction.

Implementation

Material Selection

Organic matting materials have been found to be effective where re-vegetation will be provided by re-seeding. The choice of matting should be based on the size of area, side slopes, surface conditions such as hardness, moisture, weed growth, and availability of materials.

The following natural and synthetic mattings are commonly used:

Geotextiles

- Material should be a woven polypropylene fabric with minimum thickness of 0.06 in., minimum width of 12 ft and should have minimum tensile strength of 150 lbs (warp), 80 lbs (fill) in conformance with the requirements in ASTM Designation: D 4632. The permittivity of the fabric should be approximately 0.07 sec^{-1} in conformance with the requirements in ASTM Designation: D4491. The fabric should have an ultraviolet (UV) stability of 70 percent in conformance with the requirements in ASTM designation: D4355. Geotextile blankets must be secured in place with wire staples or sandbags and by keying into tops of slopes to prevent infiltration of surface waters under geotextile. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Geotextiles may be reused if they are suitable for the use intended.

Plastic Covers

- Plastic sheeting should have a minimum thickness of 6 mils, and must be keyed in at the top of slope and firmly held in place with sandbags or other weights placed no more than 10 ft apart. Seams are typically taped or weighted down their entire length, and there should be at least a 12 in. to 24 in. overlap of all seams. Edges should be embedded a minimum of 6 in. in soil.

- All sheeting must be inspected periodically after installation and after significant rainstorms to check for erosion, undermining, and anchorage failure. Any failures must be repaired immediately. If washout or breakages occur, the material should be re-installed after repairing the damage to the slope.

Erosion Control Blankets/Mats

- Biodegradable rolled erosion control products (RECPs) are typically composed of jute fibers, curled wood fibers, straw, coconut fiber, or a combination of these materials. In order for an RECP to be considered 100% biodegradable, the netting, sewing or adhesive system that holds the biodegradable mulch fibers together must also be biodegradable.

  - **Jute** is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. It is designed to be used in conjunction with vegetation and has longevity of approximately one year. The material is supplied in rolled strips, which should be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

  - **Excelsior** (curled wood fiber) blanket material should consist of machine produced mats of curled wood excelsior with 80 percent of the fiber 6 in. or longer. The excelsior blanket should be of consistent thickness. The wood fiber must be evenly distributed over the entire area of the blanket. The top surface of the blanket should be covered with a photodegradable extruded plastic mesh. The blanket should be smolder resistant without the use of chemical additives and should be non-toxic and non-injurious to plant and animal life. Excelsior blankets should be furnished in rolled strips, a minimum of 48 in. wide, and should have an average weight of 0.8 lb/yd^2, ±10 percent, at the time of manufacture. Excelsior blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Straw blanket** should be machine produced mats of straw with a lightweight biodegradable netting top layer. The straw should be attached to the netting with biodegradable thread or glue strips. The straw blanket should be of consistent thickness. The straw should be evenly distributed over the entire area of the blanket. Straw blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Wood fiber blanket** is composed of biodegradable fiber mulch with extruded plastic netting held together with adhesives. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured to the ground with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Coconut fiber blanket** should be a machine produced mat of 100 percent coconut fiber with biodegradable netting on the top and bottom. The coconut fiber should be attached to the netting with biodegradable thread or glue strips. The coconut fiber blanket should be of consistent thickness. The coconut fiber should be evenly distributed over the entire area of the blanket. Coconut fiber blanket should be furnished in rolled strips with a minimum of 6.5 ft wide, a minimum of 80 ft. long and a minimum of 0.5 lb/yd^2. Coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- **Coconut fiber mesh** is a thin permeable membrane made from coconut or corn fiber that is spun into a yarn and woven into a biodegradable mat. It is designed to be used in conjunction with vegetation and typically has longevity of several years. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Straw coconut fiber blanket** should be machine produced mats of 70 percent straw and 30 percent coconut fiber with a biodegradable netting top layer and a biodegradable bottom net. The straw and coconut fiber should be attached to the netting with biodegradable thread or glue strips. The straw coconut fiber blanket should be of consistent thickness. The straw and coconut fiber should be evenly distributed over the entire area of the blanket. Straw coconut fiber blanket should be furnished in rolled strips a minimum of 6.5 ft wide, a minimum of 80 ft long and a minimum of 0.5 lb/yd^2. Straw coconut fiber blankets must be secured in place with wire staples. Staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.

- Non-biodegradable RECPs are typically composed of polypropylene, polyethylene, nylon or other synthetic fibers. In some cases, a combination of biodegradable and synthetic fibers is used to construct the RECP. Netting used to hold these fibers together is typically non-biodegradable as well.

- **Plastic netting** is a lightweight biaxially oriented netting designed for securing loose mulches like straw or paper to soil surfaces to establish vegetation. The netting is photodegradable. The netting is supplied in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Plastic mesh** is an open weave geotextile that is composed of an extruded synthetic fiber woven into a mesh with an opening size of less than ¼ in. It is used with re-vegetation or may be used to secure loose fiber such as straw to the ground. The material is supplied in rolled strips, which must be secured to the soil with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Synthetic fiber with netting** is a mat that is composed of durable synthetic fibers treated to resist chemicals and ultraviolet light. The mat is a dense, three dimensional mesh of synthetic (typically polyolefin) fibers stitched between two polypropylene nets. The mats are designed to be re-vegetated and provide a permanent composite system of soil, roots, and geomatrix. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Bonded synthetic fibers** consist of a three dimensional geomatrix nylon (or other synthetic) matting. Typically it has more than 90 percent open area, which facilitates root growth. It's tough root reinforcing system anchors vegetation and protects against hydraulic lift and shear forces created by high volume discharges. It can be installed over prepared soil, followed by seeding into the mat. Once vegetated, it becomes an invisible composite system of soil, roots, and geomatrix. The material is furnished in rolled strips that must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

- **Combination synthetic and biodegradable RECPs** consist of biodegradable fibers, such as wood fiber or coconut fiber, with a heavy polypropylene net stitched to the top and a high strength continuous filament geomatrix or net stitched to the bottom. The material is designed to enhance re-vegetation. The material is furnished in rolled strips, which must be secured with U-shaped staples or stakes in accordance with manufacturers' recommendations.

Site Preparation

- Proper site preparation is essential to ensure complete contact of the blanket or matting with the soil.

- Grade and shape the area of installation.

- Remove all rocks, clods, vegetation or other obstructions so that the installed blankets or mats will have complete, direct contact with the soil.

- Prepare seedbed by loosening 2 to 3 in. of topsoil.

Seeding

Seed the area before blanket installation for erosion control and revegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all check slots and other areas disturbed during installation must be re-seeded. Where soil filling is specified, seed the matting and the entire disturbed area after installation and prior to filling the mat with soil.

Fertilize and seed in accordance with seeding specifications or other types of landscaping plans. When using jute matting on a seeded area, apply approximately half the seed before laying the mat and the remainder after laying the mat. The protective matting can be laid over areas where grass has been planted and the seedlings have emerged. Where vines or other ground covers are to be planted, lay the protective matting first and then plant through matting according to design of planting.

Check Slots

Check slots are made of glass fiber strips, excelsior matting strips or tight folded jute matting blanket or strips for use on steep, highly erodible watercourses. The check slots are placed in narrow trenches 6 to 12 in. deep across the channel and left flush with the soil surface. They are to cover the full cross section of designed flow.

Laying and Securing Matting

- Before laying the matting, all check slots should be installed and the friable seedbed made free from clods, rocks, and roots. The surface should be compacted and finished according to the requirements of the manufacturer's recommendations.
- Mechanical or manual lay down equipment should be capable of handling full rolls of fabric and laying the fabric smoothly without wrinkles or folds. The equipment should meet the fabric manufacturer's recommendations or equivalent standards.

Anchoring

- U-shaped wire staples, metal geotextile stake pins, or triangular wooden stakes can be used to anchor mats and blankets to the ground surface.
- Wire staples should be made of minimum 11 gauge steel wire and should be U-shaped with 8 in. legs and 2 in. crown.
- Metal stake pins should be 0.188 in. diameter steel with a 1.5 in. steel washer at the head of the pin, and 8 in. in length.
- Wire staples and metal stakes should be driven flush to the soil surface.

Installation on Slopes

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Begin at the top of the slope and anchor the blanket in a 6 in. deep by 6 in. wide trench. Backfill trench and tamp earth firmly.
- Unroll blanket down slope in the direction of water flow.
- Overlap the edges of adjacent parallel rolls 2 to 3 in. and staple every 3 ft.

- When blankets must be spliced, place blankets end over end (shingle style) with 6 in. overlap. Staple through overlapped area, approximately 12 in. apart.
- Lay blankets loosely and maintain direct contact with the soil. Do not stretch.
- Staple blankets sufficiently to anchor blanket and maintain contact with the soil. Staples should be placed down the center and staggered with the staples placed along the edges. Steep slopes, 1:1 (H:V) to 2:1 (H:V), require a minimum of 2 staples/yd^2. Moderate slopes, 2:1 (H:V) to 3:1 (H:V), require a minimum of 1 ½ staples/yd^2.

Installation in Channels

Installation should be in accordance with the manufacturer's recommendations. In general, these will be as follows:

- Dig initial anchor trench 12 in. deep and 6 in. wide across the channel at the lower end of the project area.
- Excavate intermittent check slots, 6 in. deep and 6 in. wide across the channel at 25 to 30 ft intervals along the channels.
- Cut longitudinal channel anchor trenches 4 in. deep and 4 in. wide along each side of the installation to bury edges of matting, whenever possible extend matting 2 to 3 in. above the crest of the channel side slopes.
- Beginning at the downstream end and in the center of the channel, place the initial end of the first roll in the anchor trench and secure with fastening devices at 12 in. intervals. Note: matting will initially be upside down in anchor trench.
- In the same manner, position adjacent rolls in anchor trench, overlapping the preceding roll a minimum of 3 in.
- Secure these initial ends of mats with anchors at 12 in. intervals, backfill and compact soil.
- Unroll center strip of matting upstream. Stop at next check slot or terminal anchor trench. Unroll adjacent mats upstream in similar fashion, maintaining a 3 in. overlap.
- Fold and secure all rolls of matting snugly into all transverse check slots. Lay mat in the bottom of the slot then fold back against itself. Anchor through both layers of mat at 12 in. intervals, then backfill and compact soil. Continue rolling all mat widths upstream to the next check slot or terminal anchor trench.
- Alternate method for non-critical installations: Place two rows of anchors on 6 in. centers at 25 to 30 ft. intervals in lieu of excavated check slots.
- Staple shingled lap spliced ends a minimum of 12 in. apart on 12 in. intervals.
- Place edges of outside mats in previously excavated longitudinal slots; anchor using prescribed staple pattern, backfill, and compact soil.
- Anchor, fill, and compact upstream end of mat in a 12 in. by 6 in. terminal trench.

- Secure mat to ground surface using U-shaped wire staples, geotextile pins, or wooden stakes.
- Seed and fill turf reinforcement matting with soil, if specified.

Soil Filling (if specified for turf reinforcement)

- Always consult the manufacturer's recommendations for installation.
- Do not drive tracked or heavy equipment over mat.
- Avoid any traffic over matting if loose or wet soil conditions exist.
- Use shovels, rakes, or brooms for fine grading and touch up.
- Smooth out soil filling just exposing top netting of mat.

Temporary Soil Stabilization Removal

- Temporary soil stabilization removed from the site of the work must be disposed of if necessary.

Costs

Relatively high compared to other BMPs. Biodegradable materials: \$0.50 - \$0.57/yd². Permanent materials: \$3.00 - \$4.50/yd². Staples: \$0.04 - \$0.05/staple. Approximate costs for installed materials are shown below:

Rolled Erosion Control Products		Installed Cost per Acre
Biodegradable	Jute Mesh	$6,500
	Curled Wood Fiber	$10,500
	Straw	$8,900
	Wood Fiber	$8,900
	Coconut Fiber	$13,000
	Coconut Fiber Mesh	$31,200
	Straw Coconut Fiber	$10,900
Non-Biodegradable	Plastic Netting	$2,000
	Plastic Mesh	$3,200
	Synthetic Fiber with Netting	$34,800
	Bonded Synthetic Fibers	$50,000
	Combination with Biodegradable	$32,000

Source: Caltrans Guidance for Soil Stabilization for Temporary Slopes, Nov. 1999

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.

- Areas where erosion is evident shall be repaired and BMPs reapplied as soon as possible. Care should be exercised to minimize the damage to protected areas while making repairs, as any area damaged will require reapplication of BMPs.
- If washout or breakage occurs, re-install the material after repairing the damage to the slope or channel.
- Make sure matting is uniformly in contact with the soil.
- Check that all the lap joints are secure.
- Check that staples are flush with the ground.
- Check that disturbed areas are seeded.

References

Guides for Erosion and Sediment Controls in California, USDA Soils Conservation Service, January 1991.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Guidance Document: Soil Stabilization for Temporary Slopes, State of California Department of Transportation (Caltrans), November 1999

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

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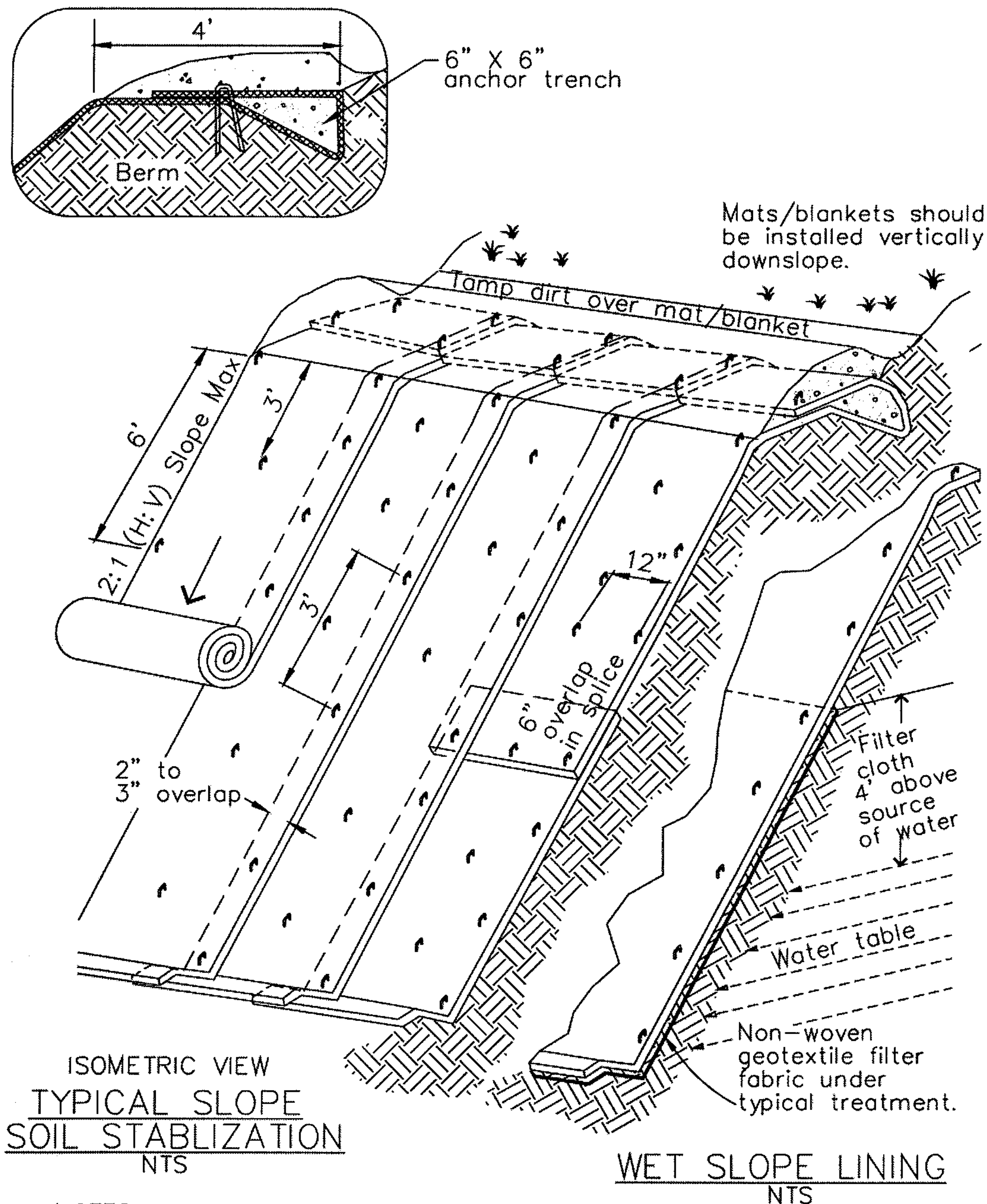
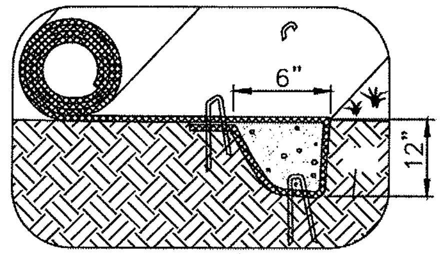


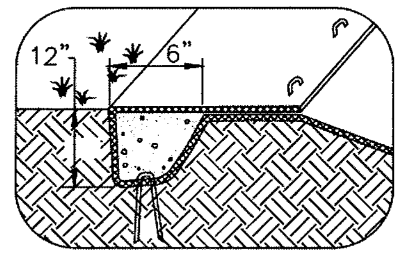
NOTES:

1. Slope surface shall be free of rocks, clods, sticks and grass. Mats/blankets shall have good soil contact.
2. Lay blankets loosely and stake or staple to maintain direct contact with the soil. Do not stretch.
3. Install per manufacturer's recommendations

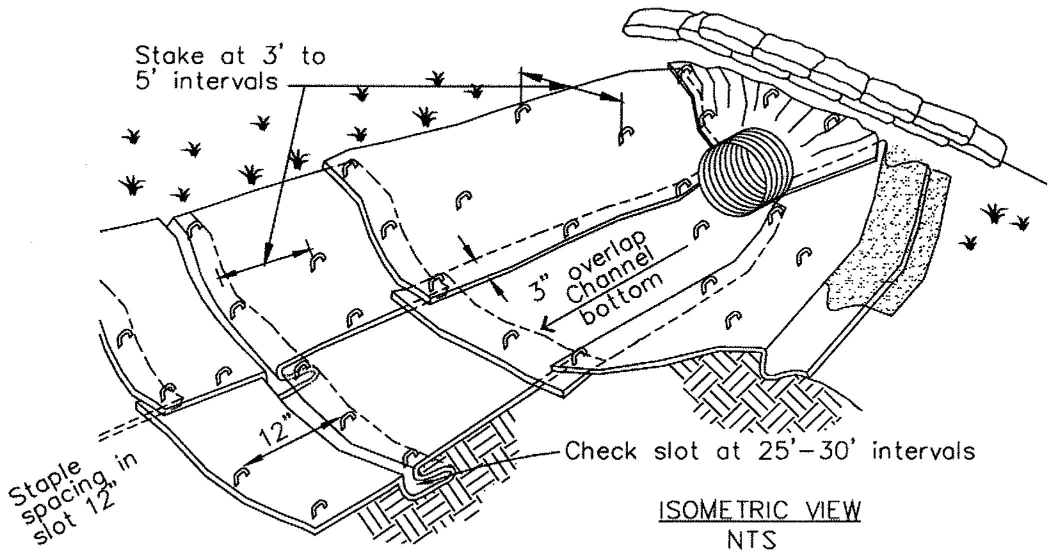
TYPICAL INSTALLATION DETAIL



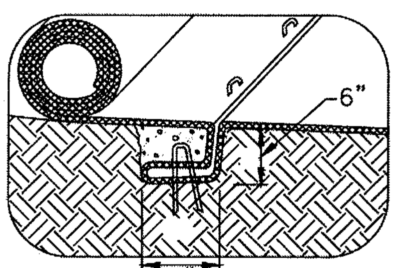
INITIAL CHANNEL ANCHOR TRENCH
NTS



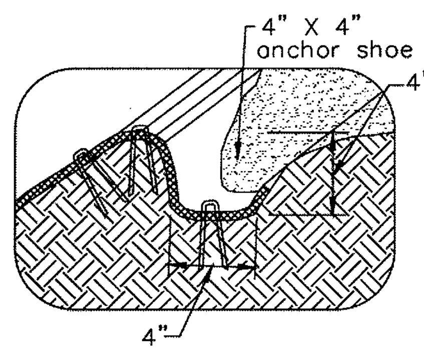
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH
NTS



ISOMETRIC VIEW
NTS



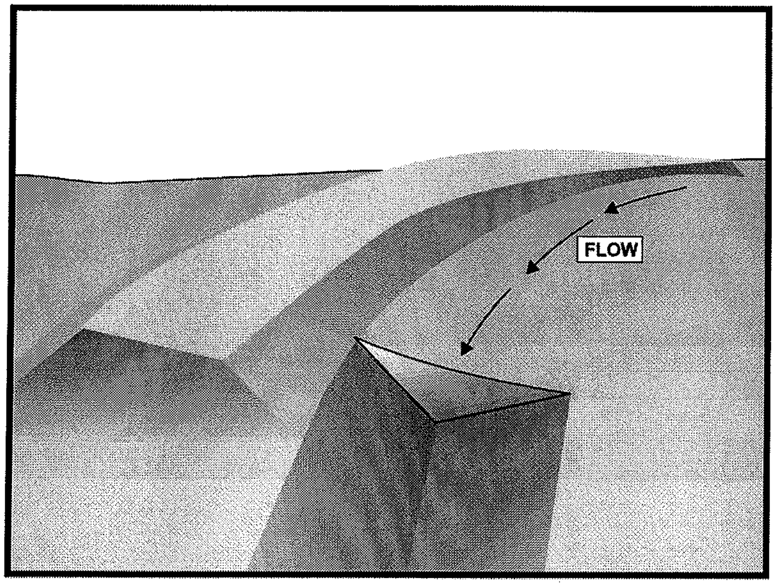
INTERMITTENT CHECK SLOT
NTS



LONGITUDINAL ANCHOR TRENCH
NTS

NOTES:
1. Check slots to be constructed per manufacturers specifications.
2. Staking or stapling layout per manufacturers specifications.
3. Install per manufacturer's recommendations

TYPICAL INSTALLATION DETAIL



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

An earth dike is a temporary berm or ridge of compacted soil used to divert runoff or channel water to a desired location. A drainage swale is a shaped and sloped depression in the soil surface used to convey runoff to a desired location. Earth dikes and drainage swales are used to divert off site runoff around the construction site, divert runoff from stabilized areas and disturbed areas, and direct runoff into sediment basins or traps.

Suitable Applications

Earth dikes and drainage swales are suitable for use, individually or together, where runoff needs to be diverted from one area and conveyed to another.

- Earth dikes and drainage swales may be used:
  - To convey surface runoff down sloping land
  - To intercept and divert runoff to avoid sheet flow over sloped surfaces
  - To divert and direct runoff towards a stabilized watercourse, drainage pipe or channel
  - To intercept runoff from paved surfaces
  - Below steep grades where runoff begins to concentrate
  - Along roadways and facility improvements subject to flood drainage

- At the top of slopes to divert runon from adjacent or undisturbed slopes
- At bottom and mid slope locations to intercept sheet flow and convey concentrated flows
- Divert sediment laden runoff into sediment basins or traps

Limitations

Dikes should not be used for drainage areas greater than 10 acres or along slopes greater than 10 percent. For larger areas more permanent drainage structures should be built. All drainage structures should be built in compliance with local municipal requirements.

- Earth dikes may create more disturbed area on site and become barriers to construction equipment.
- Earth dikes must be stabilized immediately, which adds cost and maintenance concerns.
- Diverted stormwater may cause downstream flood damage.
- Dikes should not be constructed of soils that may be easily eroded.
- Regrading the site to remove the dike may add additional cost.
- Temporary drains and swales or any other diversion of runoff should not adversely impact upstream or downstream properties.
- Temporary drains and swales must conform to local floodplain management requirements.
- Earth dikes/drainage swales are not suitable as sediment trapping devices.
- It may be necessary to use other soil stabilization and sediment controls such as check dams, plastics, and blankets, to prevent scour and erosion in newly graded dikes, swales, and ditches.

Implementation

The temporary earth dike is a berm or ridge of compacted soil, located in such a manner as to divert stormwater to a sediment trapping device or a stabilized outlet, thereby reducing the potential for erosion and offsite sedimentation. Earth dikes can also be used to divert runoff from off site and from undisturbed areas away from disturbed areas and to divert sheet flows away from unprotected slopes.

An earth dike does not itself control erosion or remove sediment from runoff. A dike prevents erosion by directing runoff to an erosion control device such as a sediment trap or directing runoff away from an erodible area. Temporary diversion dikes should not adversely impact adjacent properties and must conform to local floodplain management regulations, and should not be used in areas with slopes steeper than 10%.

Slopes that are formed during cut and fill operations should be protected from erosion by runoff. A combination of a temporary drainage swale and an earth dike at the top of a slope can divert runoff to a location where it can be brought to the bottom of the slope (see EC-11, Slope Drains). A combination dike and swale is easily constructed by a single pass of a bulldozer or grader and compacted by a second pass of the tracks or wheels over the ridge. Diversion structures should be installed when the site is initially graded and remain in place until post construction BMPs are installed and the slopes are stabilized.

Diversion practices concentrate surface runoff, increasing its velocity and erosive force. Thus, the flow out of the drain or swale must be directed onto a stabilized area or into a grade stabilization structure. If significant erosion will occur, a swale should be stabilized using vegetation, chemical treatment, rock rip-rap, matting, or other physical means of stabilization. Any drain or swale that conveys sediment laden runoff must be diverted into a sediment basin or trap before it is discharged from the site.

General

- Care must be applied to correctly size and locate earth dikes, drainage swales. Excessively steep, unlined dikes, and swales are subject to erosion and gully formation.
- Conveyances should be stabilized.
- Use a lined ditch for high flow velocities.
- Select flow velocity based on careful evaluation of the risks due to erosion of the measure, soil types, overtopping, flow backups, washout, and drainage flow patterns for each project site.
- Compact any fills to prevent unequal settlement.
- Do not divert runoff onto other property without securing written authorization from the property owner.
- When possible, install and utilize permanent dikes, swales, and ditches early in the construction process.
- Provide stabilized outlets.

Earth Dikes

Temporary earth dikes are a practical, inexpensive BMP used to divert stormwater runoff. Temporary diversion dikes should be installed in the following manner:

- All dikes should be compacted by earth moving equipment.
- All dikes should have positive drainage to an outlet.
- All dikes should have 2:1 or flatter side slopes, 18 in. minimum height, and a minimum top width of 24 in. Wide top widths and flat slopes are usually needed at crossings for construction traffic.
- The outlet from the earth dike must function with a minimum of erosion. Runoff should be conveyed to a sediment trapping device such as a Sediment Trap (SE-3) or Sediment Basin (SE-2) when either the dike channel or the drainage area above the dike are not adequately stabilized.

- Temporary stabilization may be achieved using seed and mulching for slopes less than 5% and either rip-rap or sod for slopes in excess of 5%. In either case, stabilization of the earth dike should be completed immediately after construction or prior to the first rain.
- If riprap is used to stabilize the channel formed along the toe of the dike, the following typical specifications apply:

Channel Grade	Riprap Stabilization
0.5-1.0%	4 in. Rock
1.1-2.0%	6 in. Rock
2.1-4.0%	8 in. Rock
4.1-5.0%	8 in. -12 in. Riprap

- The stone riprap, recycled concrete, etc. used for stabilization should be pressed into the soil with construction equipment.
- Filter cloth may be used to cover dikes in use for long periods.
- Construction activity on the earth dike should be kept to a minimum.

Drainage Swales

Drainage swales are only effective if they are properly installed. Swales are more effective than dikes because they tend to be more stable. The combination of a swale with a dike on the downhill side is the most cost effective diversion.

Standard engineering design criteria for small open channel and closed conveyance systems should be used (see the local drainage design manual). Unless local drainage design criteria state otherwise, drainage swales should be designed as follows:

- No more than 5 acres may drain to a temporary drainage swale.
- Place drainage swales above or below, not on, a cut or fill slope.
- Swale bottom width should be at least 2 ft
- Depth of the swale should be at least 18 in.
- Side slopes should be 2:1 or flatter.
- Drainage or swales should be laid at a grade of at least 1 percent, but not more than 15 percent.
- The swale must not be overtopped by the peak discharge from a 10-year storm, irrespective of the design criteria stated above.
- Remove all trees, stumps, obstructions, and other objectionable material from the swale when it is built.
- Compact any fill material along the path of the swale.

- Stabilize all swales immediately. Seed and mulch swales at a slope of less than 5 percent, and use rip-rap or sod for swales with a slope between 5 and 15 percent. For temporary swales, geotextiles and mats (EC-7) may provide immediate stabilization.
- Irrigation may be required to establish sufficient vegetation to prevent erosion.
- Do not operate construction vehicles across a swale unless a stabilized crossing is provided.
- Permanent drainage facilities must be designed by a professional engineer (see the local drainage design criteria for proper design).
- At a minimum, the drainage swale should conform to predevelopment drainage patterns and capacities.
- Construct the drainage swale with a positive grade to a stabilized outlet.
- Provide erosion protection or energy dissipation measures if the flow out of the drainage swale can reach an erosive velocity.

Costs

- Cost ranges from $15 to $55 per ft for both earthwork and stabilization and depends on availability of material, site location, and access.
- Small dikes: $2.50 - $6.50/linear ft; Large dikes: $2.50/yd^3.
- The cost of a drainage swale increases with drainage area and slope. Typical swales for controlling internal erosion are inexpensive, as they are quickly formed during routine earthwork.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspect ditches and berms for washouts. Replace lost riprap, damaged linings or soil stabilizers as needed.
- Inspect channel linings, embankments, and beds of ditches and berms for erosion and accumulation of debris and sediment. Remove debris and sediment and repair linings and embankments as needed.
- Temporary conveyances should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction

References

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursetynsky, P.E., McGraw Hill Book Company, 1986.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Association of Home Builders (NAHB). Stormwater Runoff & Nonpoint Source Pollution Control Guide for Builders and Developers. National Association of Home Builders, Washington, D.C., 1995

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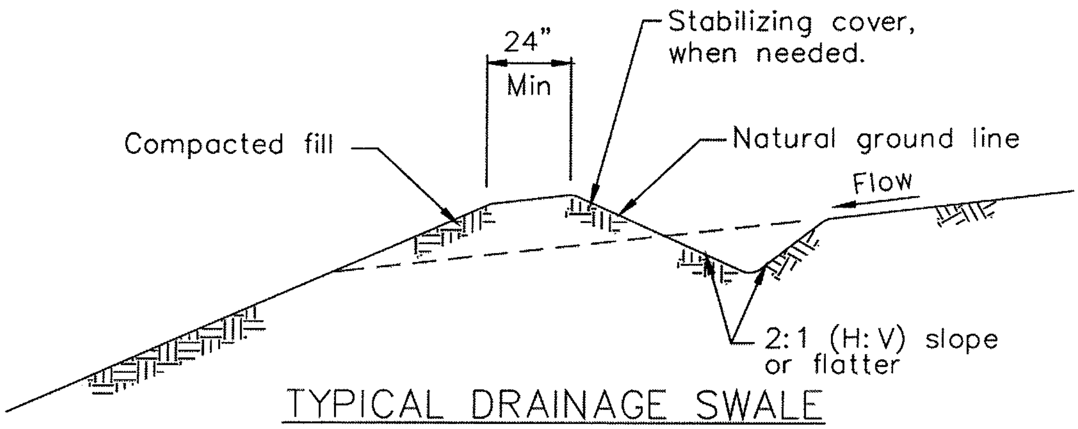
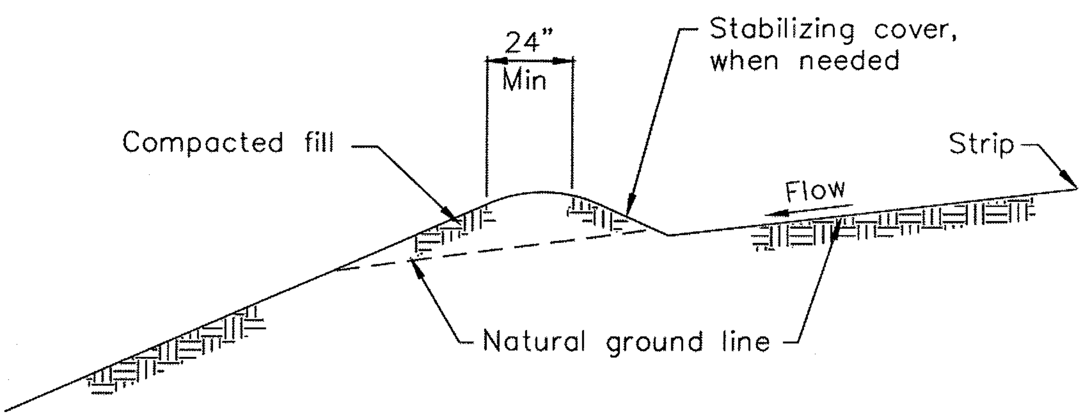


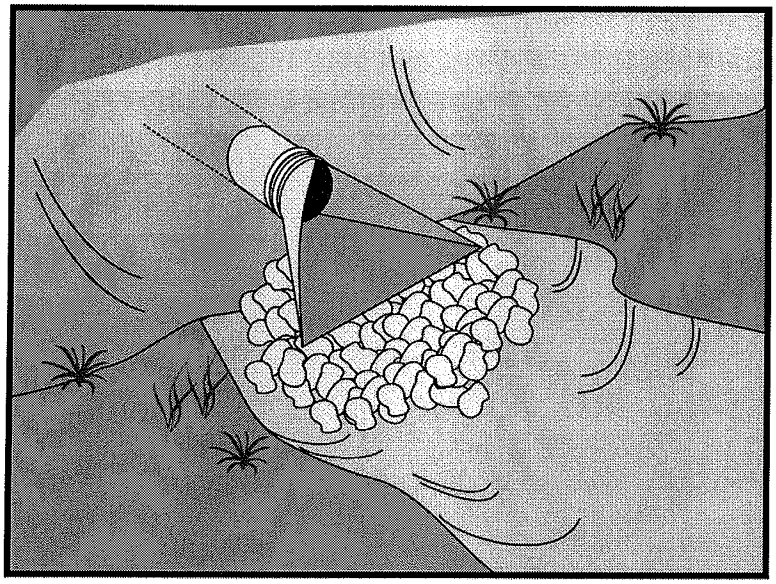
TYPICAL DRAINAGE SWALE
NOT TO SCALE

NOTES:

1. Stabilize inlet, outlets and slopes.
2. Properly compact the subgrade.



TYPICAL EARTH DIKE
NOT TO SCALE



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Outlet protection is a physical device composed of rock, grouted riprap, or concrete rubble, which is placed at the outlet of a pipe or channel to prevent scour of the soil caused by concentrated, high velocity flows.

Suitable Applications

Whenever discharge velocities and energies at the outlets of culverts, conduits, or channels are sufficient to erode the next downstream reach. This includes temporary diversion structures to divert runon during construction.

- These devices may be used at the following locations:
  - Outlets of pipes, drains, culverts, slope drains, diversion ditches, swales, conduits, or channels.
  - Outlets located at the bottom of mild to steep slopes.
  - Discharge outlets that carry continuous flows of water.
  - Outlets subject to short, intense flows of water, such as flash floods.
  - Points where lined conveyances discharge to unlined conveyances

Limitations

- Large storms or high flows can wash away the rock outlet protection and leave the area susceptible to erosion.

- Sediment captured by the rock outlet protection may be difficult to remove without removing the rock.
- Outlet protection may negatively impact the channel habitat.
- Grouted riprap may break up in areas of freeze and thaw.
- If there is not adequate drainage, and water builds up behind grouted riprap, it may cause the grouted riprap to break up due to the resulting hydrostatic pressure.

Implementation

General

Outlet protection is needed where discharge velocities and energies at the outlets of culverts, conduits or channels are sufficient to erode the immediate downstream reach. This practice protects the outlet from developing small eroded pools (plange pools), and protects against gully erosion resulting from scouring at a culvert mouth.

Design and Layout

As with most channel design projects, depth of flow, roughness, gradient, side slopes, discharge rate, and velocity should be considered in the outlet design. Compliance to local and state regulations should also be considered while working in environmentally sensitive streambeds. General recommendations for rock size and length of outlet protection mat are shown in the rock outlet protection figure in this BMP and should be considered minimums. The apron length and rock size gradation are determined using a combination of the discharge pipe diameter and estimate discharge rate: Select the longest apron length and largest rock size suggested by the pipe size and discharge rate. Where flows are conveyed in open channels such as ditches and swales, use the estimated discharge rate for selecting the apron length and rock size. Flows should be same as the culvert or channel design flow but never the less than the peak 5 year flow for temporary structures planned for one rainy season, or the 10 year peak flow for temporary structures planned for two or three rainy seasons.

- There are many types of energy dissipaters, with rock being the one that is represented in the attached figure.
- Best results are obtained when sound, durable, and angular rock is used.
- Install riprap, grouted riprap, or concrete apron at selected outlet. Riprap aprons are best suited for temporary use during construction. Grouted or wired tied rock riprap can minimize maintenance requirements.
- Rock outlet protection is usually less expensive and easier to install than concrete aprons or energy dissipaters. It also serves to trap sediment and reduce flow velocities.
- Carefully place riprap to avoid damaging the filter fabric.
  - Stone 4 in. to 6 in. may be carefully dumped onto filter fabric from a height not to exceed 12 in.
  - Stone 8 in. to 12 in. must be hand placed onto filter fabric, or the filter fabric may be covered with 4 in. of gravel and the 8 in. to 12 in. rock may be dumped from a height not to exceed 16 in.

- Stone greater than 12 in. shall only be dumped onto filter fabric protected with a layer of gravel with a thickness equal to one half the D_{50} rock size, and the dump height limited to twice the depth of the gravel protection layer thickness.

- For proper operation of apron: Align apron with receiving stream and keep straight throughout its length. If a curve is needed to fit site conditions, place it in upper section of apron.

- Outlets on slopes steeper than 10 percent should have additional protection.

Costs

Costs are low if material is readily available. If material is imported, costs will be higher. Average installed cost is $150 per device.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- Inspect BMPs subjected to non-stormwater discharges daily while non-stormwater discharges occur.

- Inspect apron for displacement of the riprap and damage to the underlying fabric. Repair fabric and replace riprap that has washed away. If riprap continues to wash away, consider using larger material.

- Inspect for scour beneath the riprap and around the outlet. Repair damage to slopes or underlying filter fabric immediately.

- Temporary devices should be completely removed as soon as the surrounding drainage area has been stabilized or at the completion of construction.

References

County of Sacramento Improvement Standards, Sacramento County, May 1989.

Erosion and Sediment Control Handbook, S.J. Goldman, K. Jackson, T.A. Bursztynsky, P.E., McGraw Hill Book Company, 1986.

Handbook of Steel Drainage & Highway Construction, American Iron and Steel Institute, 1983.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

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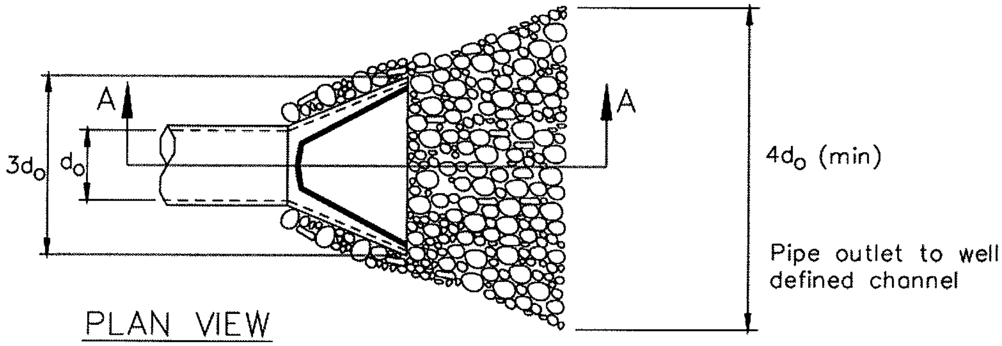
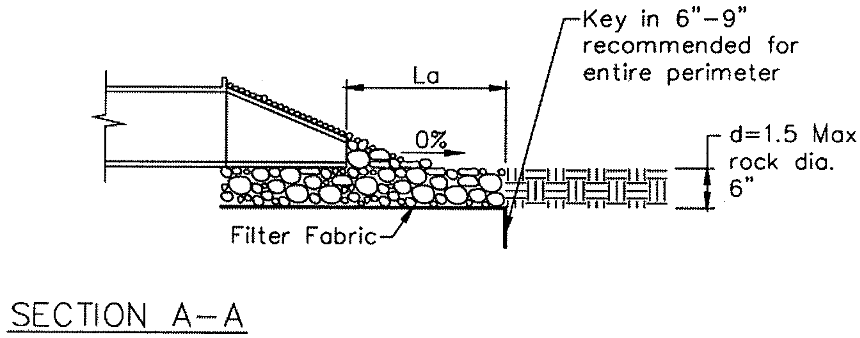
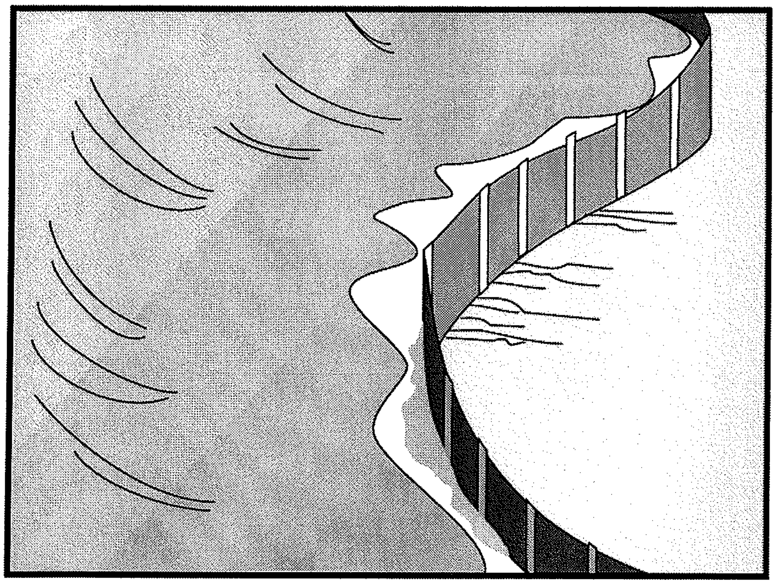




Pipe Diameter inches	Discharge ft³/s	Apron Length, La ft	Rip Rap D_{50} Diameter Min inches
12	5	10	4
	10	13	6
18	10	10	6
	20	16	8
	30	23	12
	40	26	16
24	30	16	8
	40	26	8
	50	26	12
	60	30	16

For larger or higher flows consult a Registered Civil Engineer
Source: USDA - SCS

Silt Fence



Objectives

EC	Erosion Control	☑
SE	Sediment Control	
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WE	Wind Erosion Control	
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WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

A silt fence is made of a filter fabric that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains sediment-laden water, promoting sedimentation behind the fence.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They should also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion. Silt fences are generally ineffective in locations where the flow is concentrated and are only applicable for sheet or overland flows. Silt fences are most effective when used in combination with erosion controls. Suitable applications include:

- Along the perimeter of a project.
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Below other small cleared areas.

Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.

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- Do not use in locations where ponded water may cause flooding.
- Do not place fence on a slope, or across any contour line. If not installed at the same elevation throughout, silt fences will create erosion.
- Filter fences will create a temporary sedimentation pond on the upstream side of the fence and may cause temporary flooding. Fences not constructed on a level contour will be overtopped by concentrated flow resulting in failure of the filter fence.
- Improperly installed fences are subject to failure from undercutting, overlapping, or collapsing.
  - Not effective unless trenched and keyed in.
  - Not intended for use as mid-slope protection on slopes greater than 4:1 (H:V).
  - Do not allow water depth to exceed 1.5 ft at any point.

Implementation

General

A silt fence is a temporary sediment barrier consisting of filter fabric stretched across and attached to supporting posts, entrenched, and, depending upon the strength of fabric used, supported with plastic or wire mesh fence. Silt fences trap sediment by intercepting and detaining small amounts of sediment-laden runoff from disturbed areas in order to promote sedimentation behind the fence.

Silt fences are preferable to straw bale barriers in many cases. Laboratory work at the Virginia Highway and Transportation Research Council has shown that silt fences can trap a much higher percentage of suspended sediments than can straw bales. While the failure rate of silt fences is lower than that of straw bale barriers, there are many instances where silt fences have been improperly installed. The following layout and installation guidance can improve performance and should be followed:

- Use principally in areas where sheet flow occurs.
- Don't use in streams, channels, or anywhere flow is concentrated. Don't use silt fences to divert flow.
- Don't use below slopes subject to creep, slumping, or landslides.
- Select filter fabric that retains 85% of soil by weight, based on sieve analysis, but that is not finer than an equivalent opening size of 70.
- Install along a level contour, so water does not pond more than 1.5 ft at any point along the silt fence.
- The maximum length of slope draining to any point along the silt fence should be 200 ft or less.
- The maximum slope perpendicular to the fence line should be 1:1.

- Provide sufficient room for runoff to pond behind the fence and to allow sediment removal equipment to pass between the silt fence and toes of slopes or other obstructions. About 1200 ft^2 of ponding area should be provided for every acre draining to the fence.
- Turn the ends of the filter fence uphill to prevent stormwater from flowing around the fence.
- Leave an undisturbed or stabilized area immediately down slope from the fence where feasible.
- Silt fences should remain in place until the disturbed area is permanently stabilized.

Design and Layout

Selection of a filter fabric is based on soil conditions at the construction site (which affect the equivalent opening size (EOS) fabric specification) and characteristics of the support fence (which affect the choice of tensile strength). The designer should specify a filter fabric that retains the soil found on the construction site yet that it has openings large enough to permit drainage and prevent clogging. The following criteria is recommended for selection of the equivalent opening size:

1. If 50 percent or less of the soil, by weight, will pass the U.S. Standard Sieve No. 200, select the EOS to retain 85 % of the soil. The EOS should not be finer than EOS 70.
2. For all other soil types, the EOS should be no larger than the openings in the U.S. Standard Sieve No. 70 except where direct discharge to a stream, lake, or wetland will occur, then the EOS should be no larger than Standard Sieve No. 100.

To reduce the chance of clogging, it is preferable to specify a fabric with openings as large as allowed by the criteria. No fabric should be specified with an EOS smaller than U.S. Standard Sieve No. 100. If 85% or more of a soil, by weight, passes through the openings in a No. 200 sieve, filter fabric should not be used. Most of the particles in such a soil would not be retained if the EOS was too large and they would clog the fabric quickly if the EOS were small enough to capture the soil.

The fence should be supported by a plastic or wire mesh if the fabric selected does not have sufficient strength and bursting strength characteristics for the planned application (as recommended by the fabric manufacturer). Filter fabric material should contain ultraviolet inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 °F to 120 °F.

- Layout in accordance with attached figures.
- For slopes steeper than 2:1 (H:V) and that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to install additional protection immediately adjacent to the bottom of the slope, prior to installing silt fence. Additional protection may be a chain link fence or a cable fence.
- For slopes adjacent to sensitive receiving waters or Environmentally Sensitive Areas (ESAs), silt fence should be used in conjunction with erosion control BMPs.

Materials

- Silt fence fabric should be woven polypropylene with a minimum width of 36 in. and a minimum tensile strength of 100 lb force. The fabric should conform to the requirements in ASTM designation D4632 and should have an integral reinforcement layer. The reinforcement layer should be a polypropylene, or equivalent, net provided by the manufacturer. The permittivity of the fabric should be between 0.1 sec^{-1} and 0.15 sec^{-1} in conformance with the requirements in ASTM designation D4491.

- Wood stakes should be commercial quality lumber of the size and shape shown on the plans. Each stake should be free from decay, splits or cracks longer than the thickness of the stake or other defects that would weaken the stakes and cause the stakes to be structurally unsuitable.

- Staples used to fasten the fence fabric to the stakes should be not less than 1.75 in. long and should be fabricated from 15 gauge or heavier wire. The wire used to fasten the tops of the stakes together when joining two sections of fence should be 9 gauge or heavier wire. Galvanizing of the fastening wire will not be required.

- There are new products that may use prefabricated plastic holders for the silt fence and use bar reinforcement instead of wood stakes. If bar reinforcement is used in lieu of wood stakes, use number four or greater bar. Provide end protection for any exposed bar reinforcement.

Installation Guidelines

Silt fences are to be constructed on a level contour. Sufficient area should exist behind the fence for ponding to occur without flooding or overtopping the fence.

- A trench should be excavated approximately 6 in. wide and 6 in. deep along the line the proposed silt fence.

- Bottom of the silt fence should be keyed-in a minimum of 12 in.

- Posts should be spaced a maximum of 6 ft apart and driven securely into the ground a minimum of 18 in. or 12 in. below the bottom of the trench.

- When standard strength filter fabric is used, a plastic or wire mesh support fence should be fastened securely to the upslope side of posts using heavy–duty wire staples at least 1 in. long. The mesh should extend into the trench. When extra-strength filter fabric and closer post spacing are used, the mesh support fence may be eliminated. Filter fabric should be purchased in a long roll, then cut to the length of the barrier. When joints are necessary, filter cloth should be spliced together only at a support post, with a minimum 6 in. overlap and both ends securely fastened to the post.

- The trench should be backfilled with compacted native material.

- Construct silt fences with a setback of at least 3 ft from the toe of a slope. Where a silt fence is determined to be not practicable due to specific site conditions, the silt fence may be constructed at the toe of the slope, but should be constructed as far from the toe of the slope as practicable. Silt fences close to the toe of the slope will be less effective and difficult to maintain.

- Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the barrier; in no case should the reach exceed 500 ft.

Costs

- Average annual cost for installation and maintenance (assumes 6 month useful life): $7 per lineal foot ($850 per drainage acre). Range of cost is $3.50 - $9.10 per lineal foot.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair undercut silt fences.
- Repair or replace split, torn, slumping, or weathered fabric. The lifespan of silt fence fabric is generally 5 to 8 months.
- Silt fences that are damaged and become unsuitable for the intended purpose should be removed from the site of work, disposed of, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- Silt fences should be left in place until the upstream area is permanently stabilized. Until then, the silt fence must be inspected and maintained.
- Holes, depressions, or other ground disturbance caused by the removal of the silt fences should be backfilled and repaired.

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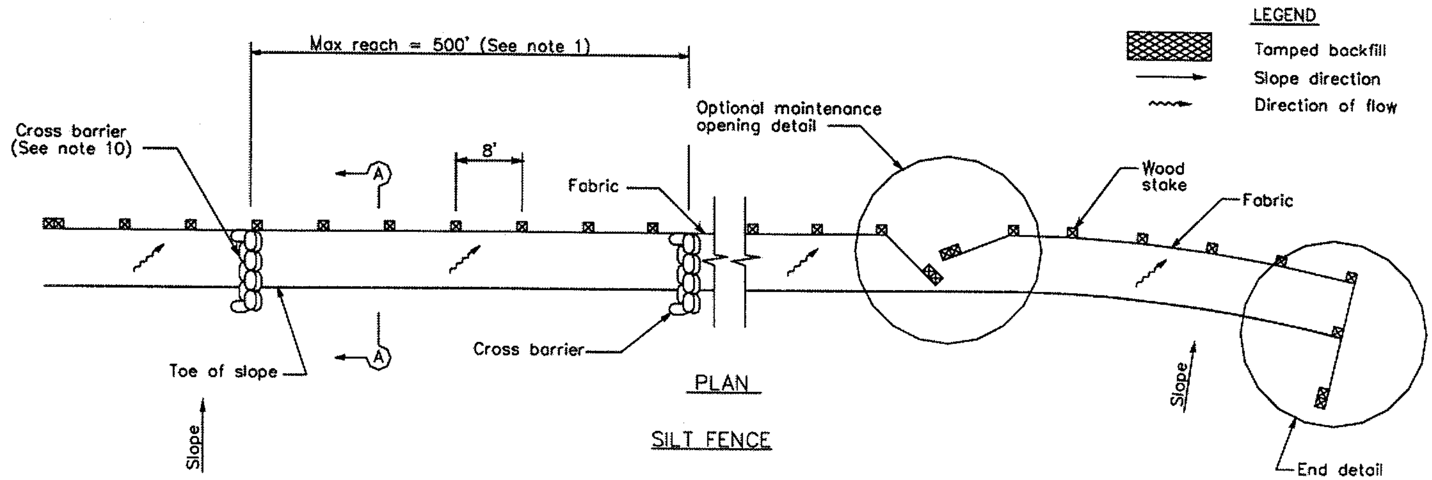
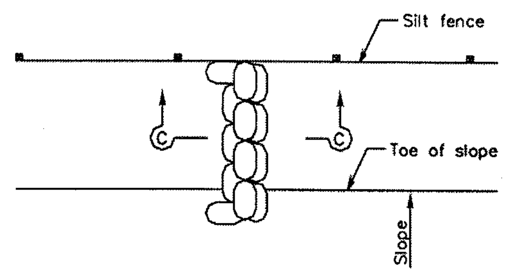


PLAN

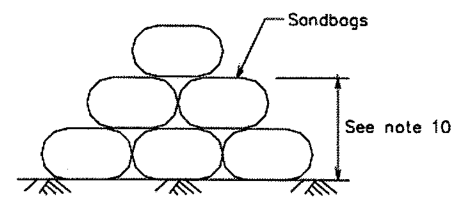
SILT FENCE

NOTES

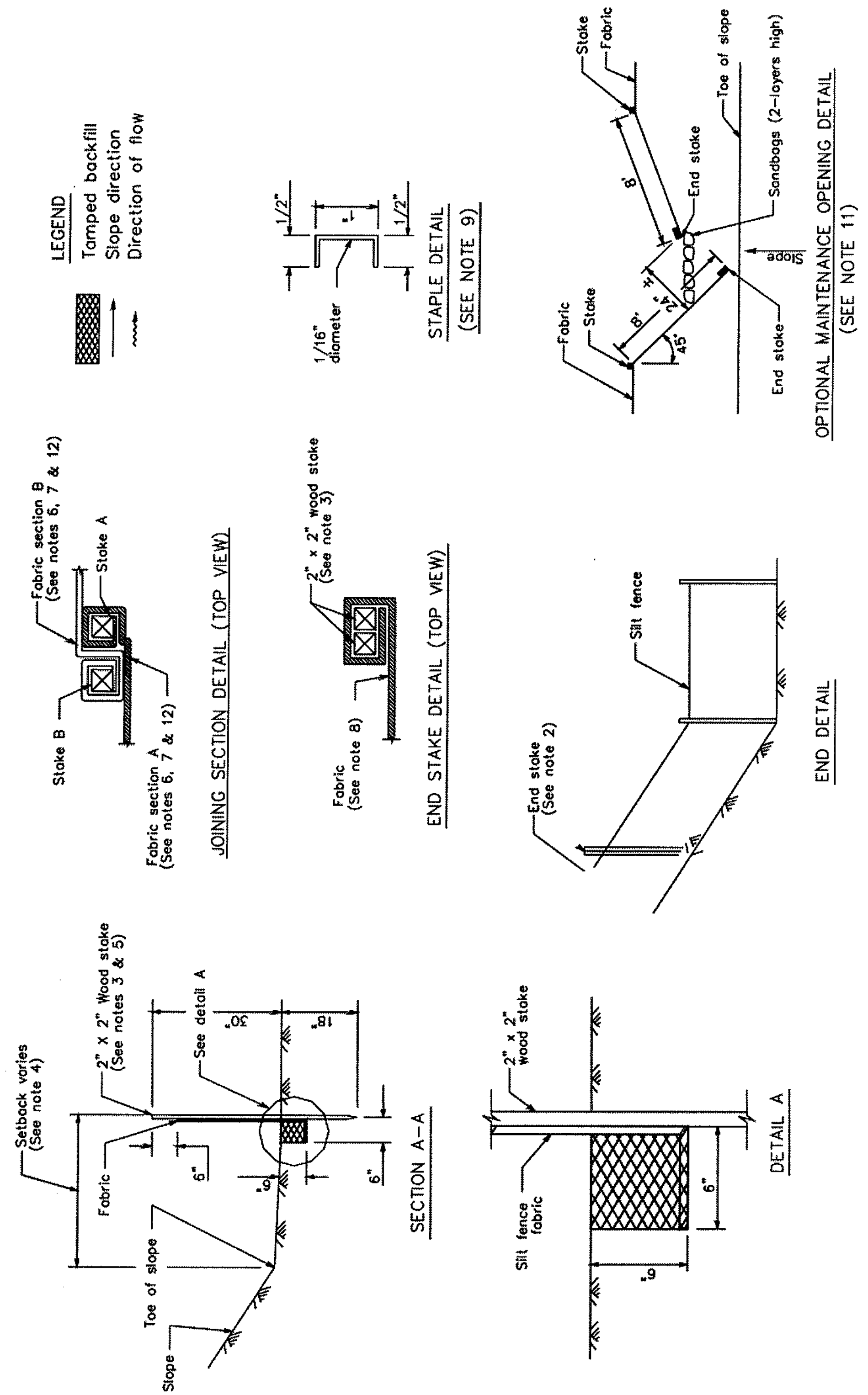
1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/3 the height of the linear barrier, in no case shall the reach length exceed 500'.
2. The last 8'-0" of fence shall be turned up slope.
3. Stake dimensions are nominal.
4. Dimension may vary to fit field condition.
5. Stakes shall be spaced at 8'-0" maximum and shall be positioned on downstream side of fence.
6. Stakes to overlap and fence fabric to fold around each stake one full turn. Secure fabric to stake with 4 staples.
7. Stakes shall be driven tightly together to prevent potential flow-through of sediment at joint. The tops of the stakes shall be secured with wire.
8. For end stake, fence fabric shall be folded around two stakes one full turn and secured with 4 staples.
9. Minimum 4 staples per stake. Dimensions shown are typical.
10. Cross barriers shall be a minimum of 1/3 and a maximum of 1/2 the height of the linear barrier.
11. Maintenance openings shall be constructed in a manner to ensure sediment remains behind silt fence.
12. Joining sections shall not be placed at sump locations.
13. Sandbag rows and layers shall be offset to eliminate gaps.



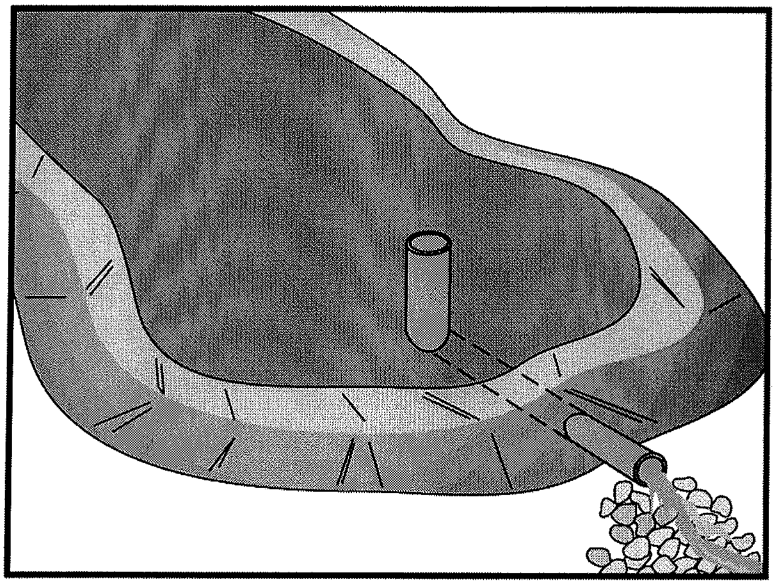
CROSS BARRIER DETAIL



SECTION C–C



LEGEND
Tamped backfill
Slope direction
Direction of flow
Setback varies (See note 4)
2" X 2" Wood stake (See notes 3 & 5)
Fabric
See detail A
Toe of slope
Slope
30"
18"
6"
6"
6"
SECTION A-A
2" x 2" wood stake
Silt fence fabric
DETAIL A
Stake B
Fabric section B (See notes 6, 7 & 12)
Stake A
Fabric section A (See notes 6, 7 & 12)
JOINING SECTION DETAIL (TOP VIEW)
2" x 2" wood stake (See note 3)
Fabric (See note 8)
END STAKE DETAIL (TOP VIEW)
End stake (See note 2)
Silt fence
END DETAIL
1/2"
1"
1/16" diameter
STAPLE DETAIL
(SEE NOTE 9)
Stake
Fabric
8'
End stake
Toe of slope
Sandbags (2-layers high)
Slope
45°
OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)



Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-3 Sediment Trap (for smaller areas)

Description and Purpose

A sediment basin is a temporary basin formed by excavation or by constructing an embankment so that sediment-laden runoff is temporarily detained under quiescent conditions, allowing sediment to settle out before the runoff is discharged.

Suitable Applications

Sediment basins may be suitable for use on larger projects with sufficient space for constructing the basin. Sediment basins should be considered for use:

- Where sediment-laden water may enter the drainage system or watercourses
- On construction projects with disturbed areas during the rainy season
- At the outlet of disturbed watersheds between 5 acres and 75 acres
- At the outlet of large disturbed watersheds, as necessary
- Where post construction detention basins are required
- In association with dikes, temporary channels, and pipes used to convey runoff from disturbed areas

Limitations

Sediment basins must be installed only within the property limits and where failure of the structure will not result in loss of life, damage to homes or buildings, or interruption of use or service of

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public roads or utilities. In addition, sediment basins are attractive to children and can be very dangerous. Local ordinances regarding health and safety must be adhered to. If fencing of the basin is required, the type of fence and its location should be shown in the SWPPP and in the construction specifications.

- Generally, sediment basins are limited to drainage areas of 5 acres or more, but not appropriate for drainage areas greater than 75 acres.
- Sediment basins may become an "attractive nuisance" and care must be taken to adhere to all safety practices. If safety is a concern, basin may require protective fencing.
- Sediment basins designed according to this handbook are only practically effective in removing sediment down to about the medium silt size fraction. Sediment-laden runoff with smaller size fractions (fine silt and clay) may not be adequately treated unless chemical treatment is used in addition to the sediment basin.
- Sites with very fine sediments (fine silt and clay) may require longer detention times for effective sediment removal.
- Basins with a height of 25 ft or more or an impounding capacity of 50 ac-ft or more must obtain approval from Division of Safety of Dams.
- Standing water may cause mosquitoes or other pests to breed.
- Basins require large surface areas to permit settling of sediment. Size may be limited by the available area.

Implementation

General

A sediment basin is a controlled stormwater release structure formed by excavation or by construction of an embankment of compacted soil across a drainage way, or other suitable location. It is intended to trap sediment before it leaves the construction site. The basin is a temporary measure with a design life of 12 to 28 months in most cases and is to be maintained until the site area is permanently protected against erosion or a permanent detention basin is constructed.

Sediment basins are suitable for nearly all types of construction projects. Whenever possible, construct the sediment basins before clearing and grading work begins. Basins should be located at the stormwater outlet from the site but not in any natural or undisturbed stream. A typical application would include temporary dikes, pipes, and/or channels to divert runoff to the basin inlet.

Many development projects in California will be required by local ordinances to provide a stormwater detention basin for post-construction flood control, desilting, or stormwater pollution control. A temporary sediment basin may be constructed by rough grading the post-construction control basins early in the project.

Sediment basins trap 70-80 % of the sediment that flows into them if designed according to this handbook. Therefore, they should be used in conjunction with erosion control practices such as temporary seeding, mulching, diversion dikes, etc., to reduce the amount of sediment flowing into the basin.

Planning

To improve the effectiveness of the basin, it should be located to intercept runoff from the largest possible amount of disturbed area. The best locations are generally low areas. Drainage into the basin can be improved by the use of earth dikes and drainage swales (see BMP EC-9). The basin must not be located in a stream but it should be located to trap sediment-laden runoff before it enters the stream. The basin should not be located where its failure would result in the loss of life or interruption of the use or service of public utilities or roads.

- Construct before clearing and grading work begins when feasible.
- Do not locate in a stream.
- Basin sites should be located where failure of the structure will not cause loss of life, damage to homes or buildings, or interruption of use or service of public roads or utilities.
- Large basins are subject to state and local dam safety requirements.
- Limit the contributing area to the sediment basin to only the runoff from the disturbed soil areas. Use temporary concentrated flow conveyance controls to divert runoff from undisturbed areas away from the sediment basin.
- The basin should be located: (1) by excavating a suitable area or where a low embankment can be constructed across a swale, (2) where post-construction (permanent) detention basins will be constructed, and (3) where the basins can be maintained on a year-round basis to provide access for maintenance, including sediment removal and sediment stockpiling in a protected area, and to maintain the basin to provide the required capacity.

Design

Sediment basins must be designed in accordance with Section A of the State of California NPDES General Permit for Stormwater Discharges Associated with Construction Activities (General Permit) where sediment basins are the only control measure proposed for the site. If there is insufficient area to construct a sediment basin in accordance with the General Permit requirements, then the alternate design standards specified herein may be used.

Sediment basins designed per the General Permit shall be designed as follows:

Option 1:

Pursuant to local ordinance for sediment basin design and maintenance, provided that the design efficiency is as protective or more protective of water quality than Option 3.

OR

Option 2:

Sediment basin(s), as measured from the bottom of the basin to the principal outlet, shall have at least a capacity equivalent to 3,600 cubic feet (133 yd^3) of storage per acre draining into the sediment basin. The length of the basin shall be more than twice the width of the basin. The length is determined by measuring the distance between the inlet and the outlet; and the depth must not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency.

OR

Option 3:
Sediment basin(s) shall be designed using the standard equation:

$$As=1.2Q/Vs \qquad \text{(Eq. 1)}$$

Where:

As = Minimum surface area for trapping soil particles of a certain size

Vs = Settling velocity of the design particle size chosen

Q = C I A

Where

Q = Discharge rate measured in cubic feet per second

C = Runoff coefficient

I = Precipitation intensity for the 10-year, 6-hour rain event

A = Area draining into the sediment basin in acres

The design particle size shall be the smallest soil grain size determined by wet sieve analysis, or the fine silt sized (0.01 mm [or 0.0004 in.]) particle, and the *Vs* used shall be 100 percent of the calculated settling velocity.

The length is determined by measuring the distance between the inlet and the outlet; the length shall be more than twice the dimension as the width; the depth shall not be less than 3 ft nor greater than 5 ft for safety reasons and for maximum efficiency (2 ft of sediment storage, 2 ft of capacity). The basin(s) shall be located on the site where it can be maintained on a year-round basis and shall be maintained on a schedule to retain the 2 ft of capacity.

OR

Option 4:
The use of an equivalent surface area design or equation, provided that the design efficiency is as protective or more protective of water quality than Option 3.

Other design considerations are:

- The volume of the settling zone should be sized to capture runoff from a 2-year storm or other appropriate design storms specified by the local agency. A detention time of 24 to 40 hours should allow 70 to 80 % of sediment to settle.
- The basin volume consists of two zones:
  - A sediment storage zone at least 1 ft deep.
  - A settling zone at least 2 ft deep.
- The length to settling depth ratio (L/SD) should be less than 200.
- Sediment basins are best used in conjunction with erosion controls. Sediment basins that will be used as the only means of treatment, without upstream erosion and sediment controls, must be designed according to the four options required by the General Permit (see Options 1-4 above). Sediment basins that are used in conjunction with upstream erosion and sediment controls should be designed to have a capacity equivalent to 67 yd^3 of sediment storage per acre of contributory area.
- The length of the basin should be more than twice the width of the basin; the length should be determined by measuring the distance between the inlet and the outlet.
- The depth must be no less than 3 ft.
- Basins with an impounding levee greater than 4.5 ft tall, measured from the lowest point to the impounding area to the highest point of the levee, and basins capable of impounding more than 35,000 ft^3, should be designed by a Registered Civil Engineer. The design should include maintenance requirements, including sediment and vegetation removal, to ensure continuous function of the basin outlet and bypass structures.
- Basins should be designed to drain within 72 hours following storm events. If a basin fails to drain within 72 hours, it must be pumped dry.
- Sediment basins, regardless of size and storage volume, should include features to accommodate overflow or bypass flows that exceed the design storm event.
  - Include an emergency spillway to accommodate flows not carried by the principal spillway. The spillway should consist of an open channel (earthen or vegetated) over undisturbed material (not fill) or constructed of a non-erodible riprap.
  - The spillway control section, which is a level portion of the spillway channel at the highest elevation in the channel, should be a minimum of 20 ft in length.
- Rock or vegetation should be used to protect the basin inlet and slopes against erosion.
- A forebay, constructed upstream of the basin may be provided to remove debris and larger particles.

- The outflow from the sediment basin should be provided with velocity dissipation devices (see BMP EC-10) to prevent erosion and scouring of the embankment and channel.
- Basin inlets should be located to maximize travel distance to the basin outlet.
- The principal outlet should consist of a corrugated metal, high density polyethylene (HDPE), or reinforced concrete riser pipe with dewatering holes and an anti-vortex device and trash rack attached to the top of the riser, to prevent floating debris from flowing out of the basin or obstructing the system. This principal structure should be designed to accommodate the inflow design storm.
- A rock pile or rock-filled gabions can serve as alternatives to the debris screen; although the designer should be aware of the potential for extra maintenance involved should the pore spaces in the rock pile clog.
- The outlet structure should be placed on a firm, smooth foundation with the base securely anchored with concrete or other means to prevent floatation.
- Attach riser pipe (watertight connection) to a horizontal pipe (barrel). Provide anti-seep collars on the barrel.
- Cleanout level should be clearly marked on the riser pipe.
- Proper hydraulic design of the outlet is critical to achieving the desired performance of the basin. The outlet should be designed to drain the basin within 24 to 72 hours (also referred to as "drawdown time"). The 24-hour limit is specified to provide adequate settling time; the 72-hour limit is specified to mitigate vector control concerns.
- The two most common outlet problems that occur are: (1) the capacity of the outlet is too great resulting in only partial filling of the basin and drawdown time less than designed for; and (2) the outlet clogs because it is not adequately protected against trash and debris. To avoid these problems, the following outlet types are recommended for use: (1) a single orifice outlet with or without the protection of a riser pipe, and (2) perforated riser. Design guidance for single orifice and perforated riser outlets follow:
  - *Flow Control Using a Single Orifice At The Bottom Of The Basin (Figure 1)*: The outlet control orifice should be sized using the following equation:

$$a = \frac{2A(H-Ho)^{0.5}}{3600CT(2g)^{0.5}} = \frac{(7x10^{-5})A(H-Ho)^{0.5}}{CT} \qquad \text{(Eq. 2)}$$

where:

a = area of orifice (ft^2)

A = surface area of the basin at mid elevation (ft^2)

C = orifice coefficient

T = drawdown time of full basin (hrs)

g = gravity (32.2 ft/s²)

H = elevation when the basin is full (ft)

Ho = final elevation when basin is empty (ft)

With a drawdown time of 40 hours, the equation becomes:

$$a = \frac{(1.75x10^{-6})A(H - Ho)^{0.5}}{C} \qquad \text{(Eq. 3)}$$

- *Flow Control Using Multiple Orifices (see Figure2):*

$$a_t = \frac{2A(h_{\max})}{3600CT(2g[h_{\max} - h_{centroid\ of\ orifices}])^{0.5}} \qquad \text{(Eq. 4)}$$

With terms as described above except:

a_t = total area of orifices

h_{max} = maximum height from lowest orifice to the maximum water surface (ft)

$h_{centroid\ of\ orifices}$ = height from the lowest orifice to the centroid of the orifice configuration (ft)

Allocate the orifices evenly on two rows; separate the holes by 3x hole diameter vertically, and by 120 degrees horizontally (refer to Figure 2).

Because basins are not maintained for infiltration, water loss by infiltration should be disregarded when designing the hydraulic capacity of the outlet structure.

Care must be taken in the selection of "C"; 0.60 is most often recommended and used. However, based on actual tests, GKY (1989), "Outlet Hydraulics of Extended Detention Facilities for Northern Virginia Planning District Commission", recommends the following:

C = 0.66 for thin materials; where the thickness is equal to or less than the orifice diameter, or

C = 0.80 when the material is thicker than the orifice diameter

Installation

- Securely anchor and install an anti-seep collar on the outlet pipe/riser and provide an emergency spillway for passing major floods (see local flood control agency).
- Areas under embankments must be cleared and stripped of vegetation.
- Chain link fencing should be provided around each sediment basin to prevent unauthorized entry to the basin or if safety is a concern.

Costs

Average annual costs for installation and maintenance (2 year useful life) are:

- Basin less than 50,000 ft^3: Range, \$0.24 - \$1.58/ft^3. Average, \$0.73 per ft^3. \$400 - \$2,400, \$1,200 average per drainage acre.
- Basin size greater than 50,000 ft^3: Range, \$0.12 – \$0.48/ft^3. Average, \$0.36 per ft^3. \$200 - \$800, \$600 average per drainage acre.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Examine basin banks for seepage and structural soundness.
- Check inlet and outlet structures and spillway for any damage or obstructions. Repair damage and remove obstructions as needed.
- Check inlet and outlet area for erosion and stabilize if required.
- Check fencing for damage and repair as needed.
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage volume. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed of at appropriate locations.
- Remove standing water from basin within 72 hours after accumulation.
- BMPs that require dewatering shall be continuously attended while dewatering takes place. Dewatering BMPs shall be implemented at all times during dewatering activities.
- To minimize vector production:
  - Remove accumulation of live and dead floating vegetation in basins during every inspection.
  - Remove excessive emergent and perimeter vegetation as needed or as advised by local or state vector control agencies.

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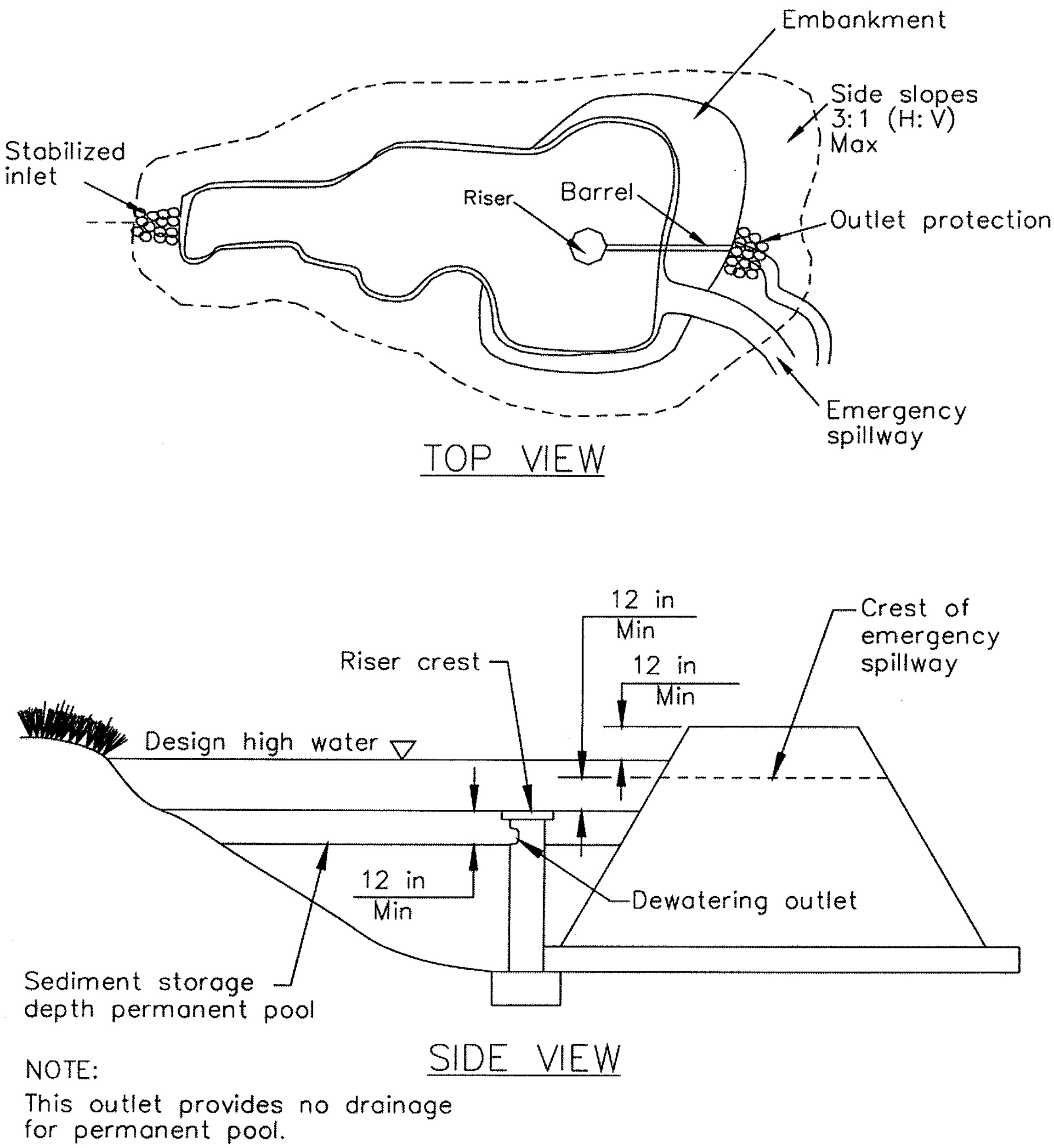
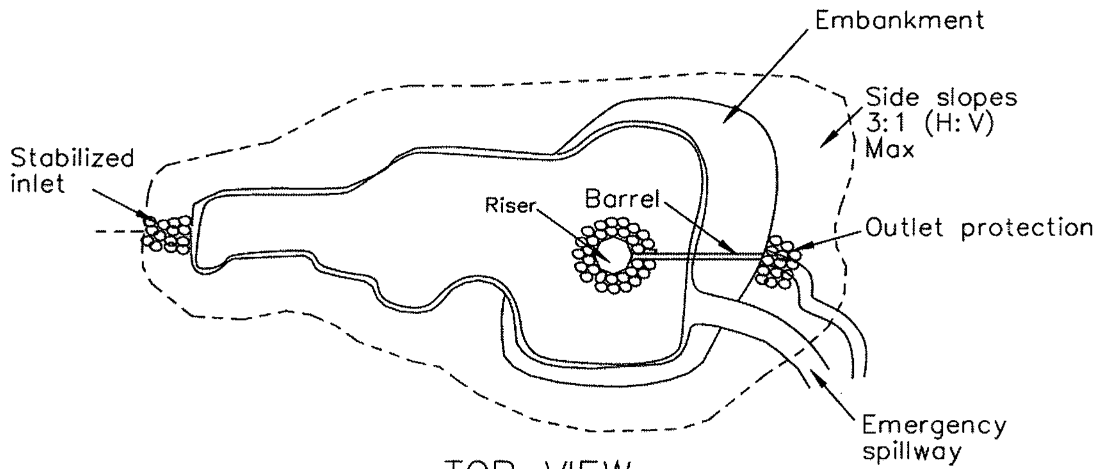
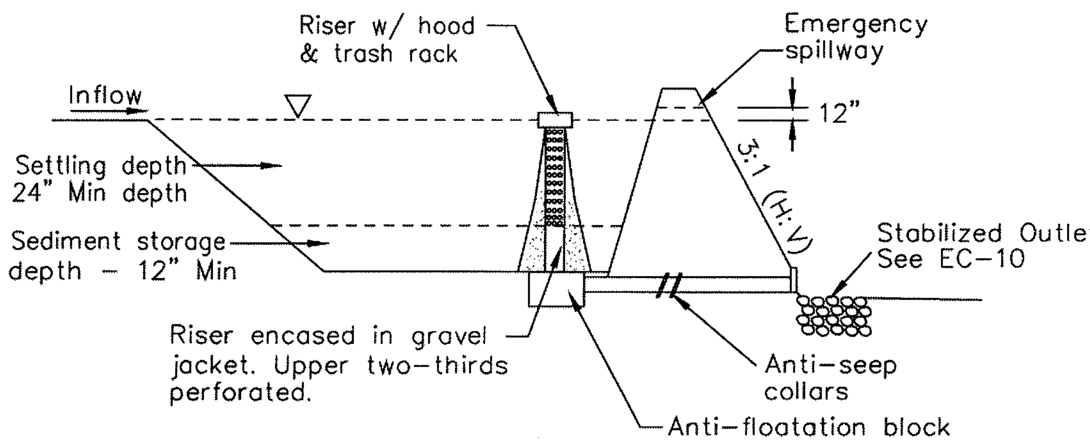


FIGURE 1: TYPICAL TEMPORARY SEDIMENT BASIN SINGLE ORIFICE DESIGN

NOT TO SCALE



TOP VIEW



SIDE VIEW

FIGURE 2: TYPICAL TEMPORARY SEDIMENT BASIN MULTIPLE ORIFICE DESIGN

NOT TO SCALE

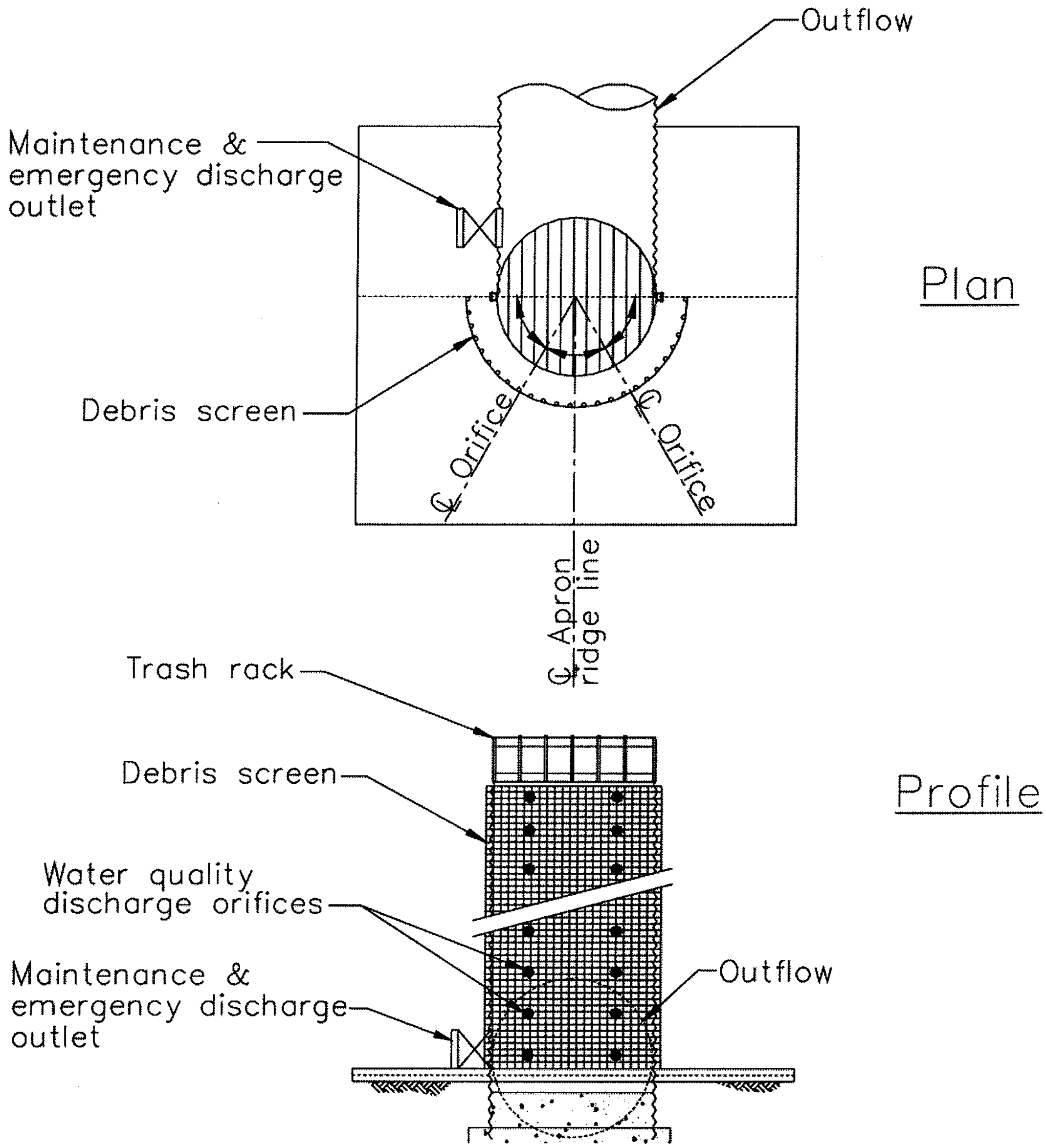
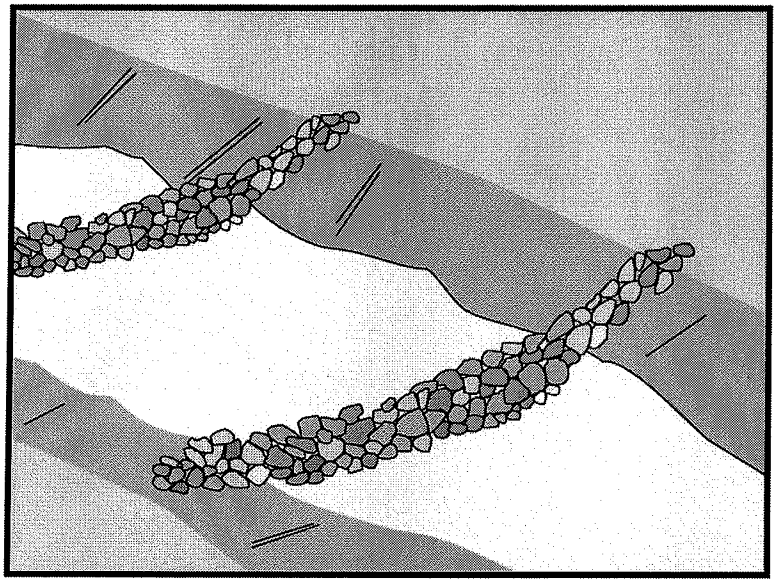


FIGURE 3: MULTIPLE ORIFICE OUTLET RISER

NOT TO SCALE

Check Dams SE-4



Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or reusable products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing the velocity of flowing water, allowing sediment to settle and reducing erosion.

Suitable Applications

Check dams may be appropriate in the following situations:

- To promote sedimentation behind the dam.
- To prevent erosion by reducing the velocity of channel flow in small intermittent channels and temporary swales.
- In small open channels that drain 10 acres or less.
- In steep channels where stormwater runoff velocities exceed 5 ft/s.
- During the establishment of grass linings in drainage ditches or channels.
- In temporary ditches where the short length of service does not warrant establishment of erosion-resistant linings.

Limitations

- Not to be used in live streams or in channels with extended base flows.

Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

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- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion is expected, as installation may damage vegetation.
- Require extensive maintenance following high velocity flows.
- Promotes sediment trapping which can be re-suspended during subsequent storms or removal of the check dam.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Reduced slopes reduce the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Use of check dams for sedimentation will likely result in little net removal of sediment because of the small detention time and probable scour during longer storms. Using a series of check dams will generally increase their effectiveness. A sediment trap (SE-3) may be placed immediately upstream of the check dam to increase sediment removal efficiency.

Design and Layout

Check dams work by decreasing the effective slope in ditches and swales. An important consequence of the reduced slope is a reduction in capacity of the ditch or swale. This reduction in capacity must be considered when using this BMP, as reduced capacity can result in overtopping of the ditch or swale and resultant consequences. In some cases, such as a "permanent" ditch or swale being constructed early and used as a "temporary" conveyance for construction flows, the ditch or swale may have sufficient capacity such that the temporary reduction in capacity due to check dams is acceptable. When check dams reduce capacities beyond acceptable limits, there are several options:

- Don't use check dams. Consider alternative BMPs.
- Increase the size of the ditch or swale to restore capacity.

Maximum slope and velocity reduction is achieved when the toe of the upstream dam is at the same elevation as the top of the downstream dam. The center section of the dam should be lower than the edge sections so that the check dam will direct flows to the center of the ditch or swale.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products manufactured specifically for use as check dams are also being used, and some of these products can be removed and reused. Check dams can also be constructed of logs or lumber, and have the advantage of a longer lifespan when compared to gravel bags, sandbags, and fiber rolls. Straw bales can also be used for check dams and can work if correctly installed; but in practice, straw bale check dams have a high failure rate. Check dams should not be constructed from straw bales or silt fences, since concentrated flows quickly wash out these materials.

Rock check dams are usually constructed of 8 to 12 in. rock. The rock is placed either by hand or mechanically, but never just dumped into the channel. The dam must completely span the ditch or swale to prevent washout. The rock used must be large enough to stay in place given the expected design flow through the channel.

Log check dams are usually constructed of 4 to 6 in. diameter logs. The logs should be embedded into the soil at least 18 in. Logs can be bolted or wired to vertical support logs that have been driven or buried into the soil.

Gravel bag and sandbag check dams are constructed by stacking bags across the ditch or swale, shaped as shown in the drawings at the end of this fact sheet.

Manufactured products should be installed in accordance with the manufacturer's instructions.

If grass is planted to stabilize the ditch or swale, the check dam should be removed when the grass has matured (unless the slope of the swales is greater than 4%).

The following guidance should be followed for the design and layout of check dams:

- Install the first check dam approximately 16 ft from the outfall device and at regular intervals based on slope gradient and soil type.
- Check dams should be placed at a distance and height to allow small pools to form between each check dam.
- Backwater from a downstream check dam should reach the toes of the upstream check dam.
- A sediment trap provided immediately upstream of the check dam will help capture sediment. Due to the potential for this sediment to be resuspended in subsequent storms, the sediment trap must be cleaned following each storm event.
- High flows (typically a 2-year storm or larger) should safely flow over the check dam without an increase in upstream flooding or damage to the check dam.
- Where grass is used to line ditches, check dams should be removed when grass has matured sufficiently to protect the ditch or swale.
- Gravel bags may be used as check dams with the following specifications:

Materials
Gravel bags used for check dams should conform to the requirements of SE-6, Gravel Bag Berms. Sandbags used for check dams should conform to SE-8, Sandbag Barrier. Fiber rolls used for check dams should conform to SE-5, Fiber Rolls. Straw bales used for check dams should conform to SE-9, Straw Bale Barrier.

Installation
- Rock should be placed individually by hand or by mechanical methods (no dumping of rock) to achieve complete ditch or swale coverage.
- Tightly abut bags and stack according to detail shown in the figure at the end of this section. Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Fiber rolls and straw bales must be trenched in and firmly staked in place.

Costs
Cost consists of only installation costs if materials are readily available. If material must be imported, costs may increase. For material costs, see SE-5, SE-6, SE-8 and SE-9.

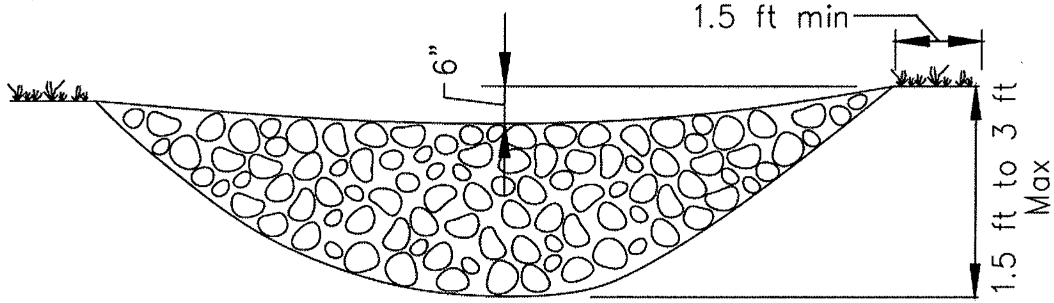
Inspection and Maintenance
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Replace missing rock, bags, bales, etc. Replace bags or bales that have degraded or have become damaged.
- If the check dam is used as a sediment capture device, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site or disposed at an appropriate location.
- If the check dam is used as a grade control structure, sediment removal is not required as long as the system continues to control the grade.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

References
Draft – Sedimentation and Erosion Control, and Inventory of Current Practices, USEPA, April 1990.

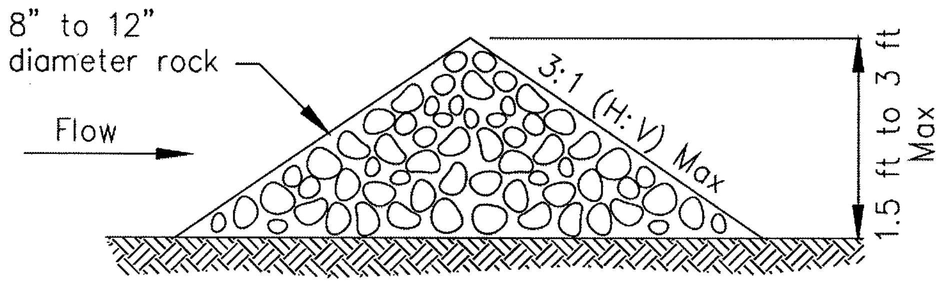
Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

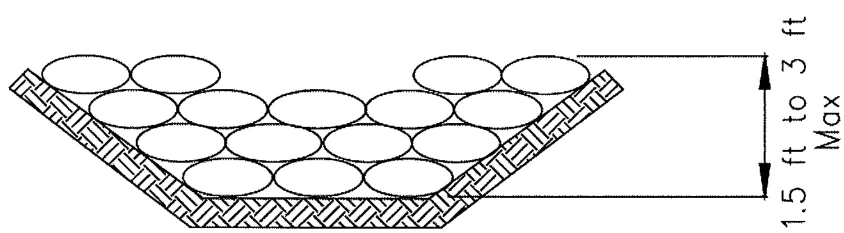


ELEVATION



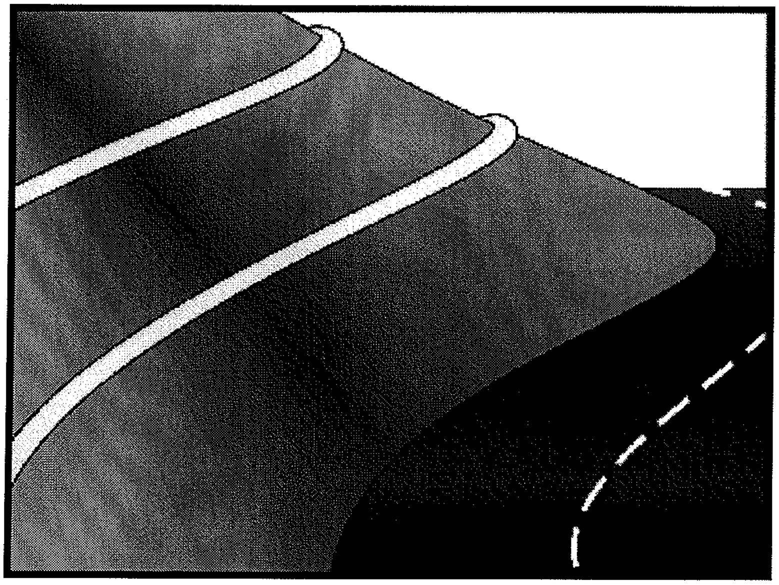
TYPICAL ROCK CHECK DAM SECTION

ROCK CHECK DAM
NOT TO SCALE



GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE

Fiber Rolls SE-5



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:
☑ **Primary Objective**
☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence
SE-6 Gravel Bag Berm
SE-8 Sandbag Barrier
SE-9 Straw Bale Barrier

Description and Purpose

A fiber roll consists of straw, flax, or other similar materials bound into a tight tubular roll. When fiber rolls are placed at the toe and on the face of slopes, they intercept runoff, reduce its flow velocity, release the runoff as sheet flow, and provide removal of sediment from the runoff. By interrupting the length of a slope, fiber rolls can also reduce erosion.

Suitable Applications

Fiber rolls may be suitable:

- Along the toe, top, face, and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow
- At the end of a downward slope where it transitions to a steeper slope
- Along the perimeter of a project
- As check dams in unlined ditches
- Down-slope of exposed soil areas
- Around temporary stockpiles

Limitations

- Fiber rolls are not effective unless trenched

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- Fiber rolls at the toe of slopes greater than 5:1 (H:V) should be a minimum of 20 in. diameter or installations achieving the same protection (i.e. stacked smaller diameter fiber rolls, etc.).
- Difficult to move once saturated.
- If not properly staked and trenched in, fiber rolls could be transported by high flows.
- Fiber rolls have a very limited sediment capture zone.
- Fiber rolls should not be used on slopes subject to creep, slumping, or landslide.

Implementation

Fiber Roll Materials

- Fiber rolls should be either prefabricated rolls or rolled tubes of erosion control blanket.

Assembly of Field Rolled Fiber Roll

- Roll length of erosion control blanket into a tube of minimum 8 in. diameter.
- Bind roll at each end and every 4 ft along length of roll with jute-type twine.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination of 4:1 (H:V) or flatter: Fiber rolls should be placed at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Fiber Rolls should be placed at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Fiber Rolls should be placed at a maximum interval of 10 ft. (a closer spacing is more effective).
- Turn the ends of the fiber roll up slope to prevent runoff from going around the roll.
- Stake fiber rolls into a 2 to 4 in. deep trench with a width equal to the diameter of the fiber roll.
  - Drive stakes at the end of each fiber roll and spaced 4 ft maximum on center.
  - Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- If more than one fiber roll is placed in a row, the rolls should be overlapped, not abutted.

Removal

- Fiber rolls are typically left in place.

- If fiber rolls are removed, collect and dispose of sediment accumulation, and fill and compact holes, trenches, depressions or any other ground disturbance to blend with adjacent ground.

Costs

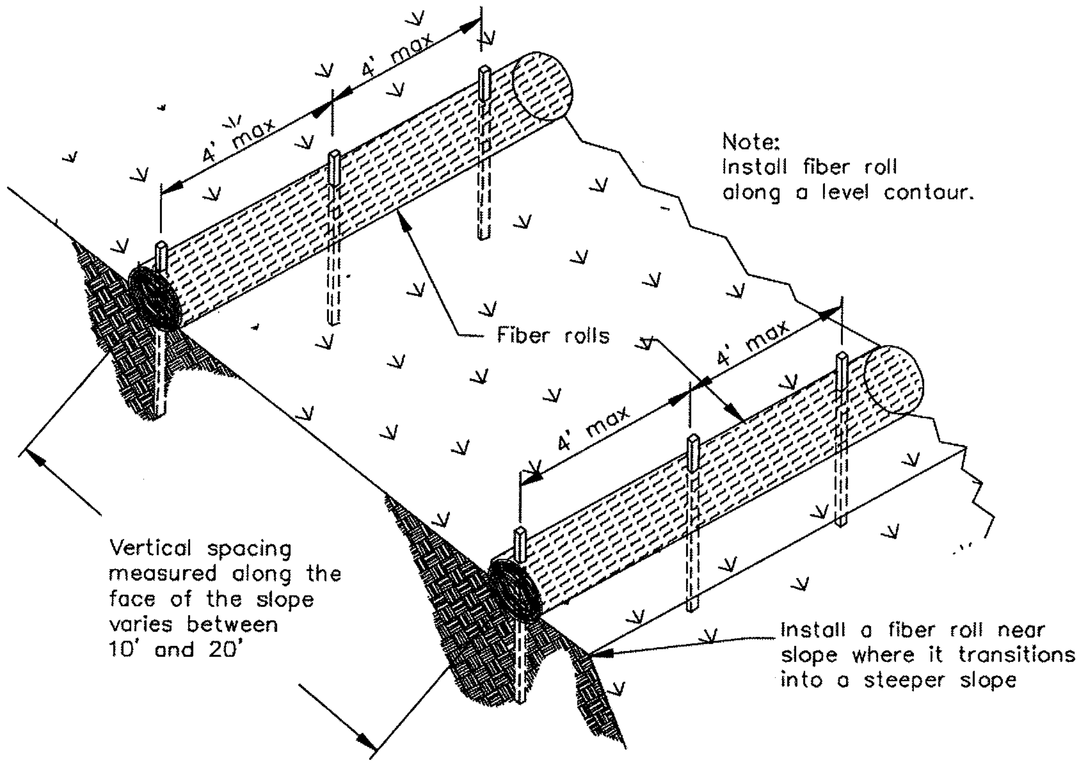
Material costs for fiber rolls range from $20 - $30 per 25 ft roll.

Inspection and Maintenance

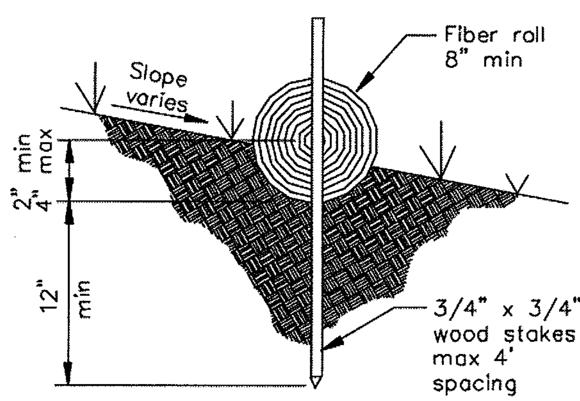
- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.
- Repair or replace split, torn, unraveling, or slumping fiber rolls.
- If the fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when sediment accumulation reaches one-half the designated sediment storage depth, usually one-half the distance between the top of the fiber roll and the adjacent ground surface. Sediment removed during maintenance may be incorporated into earthwork on the site of disposed at an appropriate location.
- If fiber rolls are used for erosion control, such as in a mini check dam, sediment removal should not be required as long as the system continues to control the grade. Sediment control BMPs will likely be required in conjunction with this type of application.

References

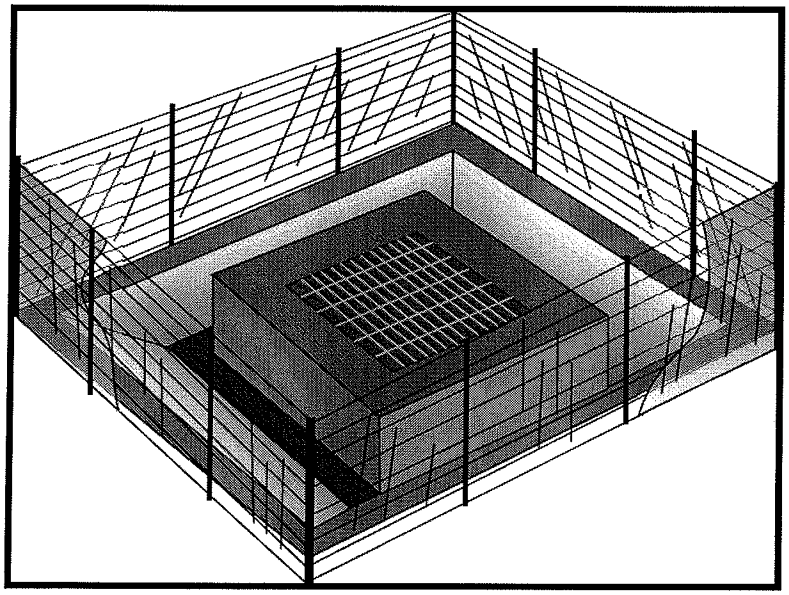
Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.



TYPICAL FIBER ROLL INSTALLATION
N.T.S.



ENTRENCHMENT DETAIL
N.T.S.



Objectives

EC	Erosion Control	
SE	Sediment Control	☑
TR	Tracking Control	
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	☑
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm

SE-8 Sandbag Barrier

SE-9 Straw Bale Barrier

Description and Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area around or upstream of a storm drain, drop inlet, or curb inlet. Storm drain inlet protection measures temporarily pond runoff before it enters the storm drain, allowing sediment to settle. Some filter configurations also remove sediment by filtering, but usually the ponding action results in the greatest sediment reduction.

Suitable Applications

Every storm drain inlet receiving sediment-laden runoff should be protected.

Limitations

- Drainage area should not exceed 1 acre.
- Straw bales, while potentially effective, have not produced in practice satisfactory results, primarily due to improper installation.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.
- Inlet protection usually requires other methods of temporary protection to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm drain system.
- Sediment removal may be difficult in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are

expected, use other onsite sediment trapping techniques in conjunction with inlet protection.

- Frequent maintenance is required.
- For drainage areas larger than 1 acre, runoff should be routed to a sediment-trapping device designed for larger flows. See BMPs SE-2, Sediment Basin, and SE-3, Sediment Traps.
- Excavated drop inlet sediment traps are appropriate where relatively heavy flows are expected, and overflow capability is needed.

Implementation

General

Large amounts of sediment may enter the storm drain system when storm drains are installed before the upslope drainage area is stabilized, or where construction is adjacent to an existing storm drain. In cases of extreme sediment loading, the storm drain itself may clog and lose a major portion of its capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

Inlet control measures presented in this handbook should not be used for inlets draining more than one acre. Runoff from larger disturbed areas should be first routed through SE-2, Sediment Basin or SE-3, Sediment Trap. Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Inlet protection methods not presented in this handbook should be approved by the local stormwater management agency.

Design and Layout

Identify existing and planned storm drain inlets that have the potential to receive sediment-laden surface runoff. Determine if storm drain inlet protection is needed and which method to use.

- Limit upstream drainage area to 1 acre maximum. For larger drainage areas, use SE-2, Sediment Basin, or SE-3, Sediment Trap, upstream of the inlet protection device.
- The key to successful and safe use of storm drain inlet protection devices is to know where runoff will pond or be diverted.
  - Determine the acceptable location and extent of ponding in the vicinity of the drain inlet. The acceptable location and extent of ponding will influence the type and design of the storm drain inlet protection device.
  - Determine the extent of potential runoff diversion caused by the storm drain inlet protection device. Runoff ponded by inlet protection devices may flow around the device and towards the next downstream inlet. In some cases, this is acceptable; in other cases, serious erosion or downstream property damage can be caused by these diversions. The possibility of runoff diversions will influence whether or not storm drain inlet protection is suitable; and, if suitable, the type and design of the device.
- The location and extent of ponding, and the extent of diversion, can usually be controlled through appropriate placement of the inlet protection device. In some cases, moving the

inlet protection device a short distance upstream of the actual inlet can provide more efficient sediment control, limit ponding to desired areas, and prevent or control diversions.

- Four types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.
  - Filter Fabric Fence: Appropriate for drainage basins with less than a 5% slope, sheet flows, and flows under 0.5 cfs.
  - Excavated Drop Inlet Sediment Trap: An excavated area around the inlet to trap sediment (SE-3).
  - Gravel bag barrier: Used to create a small sediment trap upstream of inlets on sloped, paved streets. Appropriate for sheet flow or when concentrated flow may exceed 0.5 cfs, and where overtopping is required to prevent flooding.
  - Block and Gravel Filter: Appropriate for flows greater than 0.5 cfs.
- Select the appropriate type of inlet protection and design as referred to or as described in this fact sheet.
- Provide area around the inlet for water to pond without flooding structures and property.
- Grates and spaces around all inlets should be sealed to prevent seepage of sediment-laden water.
- Excavate sediment sumps (where needed) 1 to 2 ft with 2:1 side slopes around the inlet.

Installation

- ***DI Protection Type 1 - Filter Fabric Fence*** - The filter fabric fence (Type 1) protection is shown in the attached figure. Similar to constructing a silt fence; see BMP SE-1, Silt Fence. Do not place filter fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced.

  1. Excavate a trench approximately 6 in. wide and 6 in. deep along the line of the silt fence inlet protection device.
  2. Place 2 in. by 2 in. wooden stakes around the perimeter of the inlet a maximum of 3 ft apart and drive them at least 18 in. into the ground or 12 in. below the bottom of the trench. The stakes must be at least 48 in.
  3. Lay fabric along bottom of trench, up side of trench, and then up stakes. See SE-1, Silt Fence, for details. The maximum silt fence height around the inlet is 24 in.
  4. Staple the filter fabric (for materials and specifications, see SE-1, Silt Fence) to wooden stakes. Use heavy-duty wire staples at least 1 in. in length.
  5. Backfill the trench with gravel or compacted earth all the way around.

- ***DI Protection Type 2 - Excavated Drop Inlet Sediment Trap*** - The excavated drop inlet sediment trap (Type 2) is shown in the attached figures. Install filter fabric fence in accordance with DI Protection Type 1. Size excavated trap to provide a minimum storage capacity calculated at the rate 67 yd^3/acre of drainage area.

- ***DI Protection Type 3 - Gravel bag*** - The gravel bag barrier (Type 3) is shown in the figures. Flow from a severe storm should not overtop the curb. In areas of high clay and silts, use filter fabric and gravel as additional filter media. Construct gravel bags in accordance with SE-6, Gravel Bag Berm. Gravel bags should be used due to their high permeability.

  1. Use sand bag made of geotextile fabric (not burlap) and fill with 0.75 in. rock or 0.25 in. pea gravel.
  2. Construct on gently sloping street.
  3. Leave room upstream of barrier for water to pond and sediment to settle.
  4. Place several layers of sand bags – overlapping the bags and packing them tightly together.
  5. Leave gap of one bag on the top row to serve as a spillway. Flow from a severe storm (e.g., 10 year storm) should not overtop the curb.

- ***DI Protection Type 4 – Block and Gravel Filter*** - The block and gravel filter (Type 4) is shown in the figures. Block and gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction.

  1. Place hardware cloth or comparable wire mesh with 0.5 in. openings over the drop inlet so that the wire extends a minimum of 1 ft beyond each side of the inlet structure. If more than one strip is necessary, overlap the strips. Place filter fabric over the wire mesh.
  2. Place concrete blocks lengthwise on their sides in a single row around the perimeter of the inlet, so that the open ends face outward, not upward. The ends of adjacent blocks should abut. The height of the barrier can be varied, depending on design needs, by stacking combinations of blocks that are 4 in., 8 in., and 12 in. wide. The row of blocks should be at least 12 in. but no greater than 24 in. high.
  3. Place wire mesh over the outside vertical face (open end) of the concrete blocks to prevent stone from being washed through the blocks. Use hardware cloth or comparable wire mesh with 0.5 in. opening.
  4. Pile washed stone against the wire mesh to the top of the blocks. Use 0.75 to 3 in.

Costs

- Average annual cost for installation and maintenance (one year useful life) is $200 per inlet.

Inspection and Maintenance

- Inspect BMPs prior to forecast rain, daily during extended rain events, after rain events, weekly during the rainy season, and at two-week intervals during the non-rainy season.

- Filter Fabric Fences. If the fabric becomes clogged, torn, or degrades, it should be replaced. Make sure the stakes are securely driven in the ground and are in good shape (i.e., not bent, cracked, or splintered, and are reasonably perpendicular to the ground). Replace damaged stakes.

- Gravel Filters. If the gravel becomes clogged with sediment, it must be carefully removed from the inlet and either cleaned or replaced. Since cleaning gravel at a construction site may be difficult, consider using the sediment-laden stone as fill material and put fresh stone around the inlet. Inspect bags for holes, gashes, and snags, and replace bags as needed. Check gravel bags for proper arrangement and displacement.

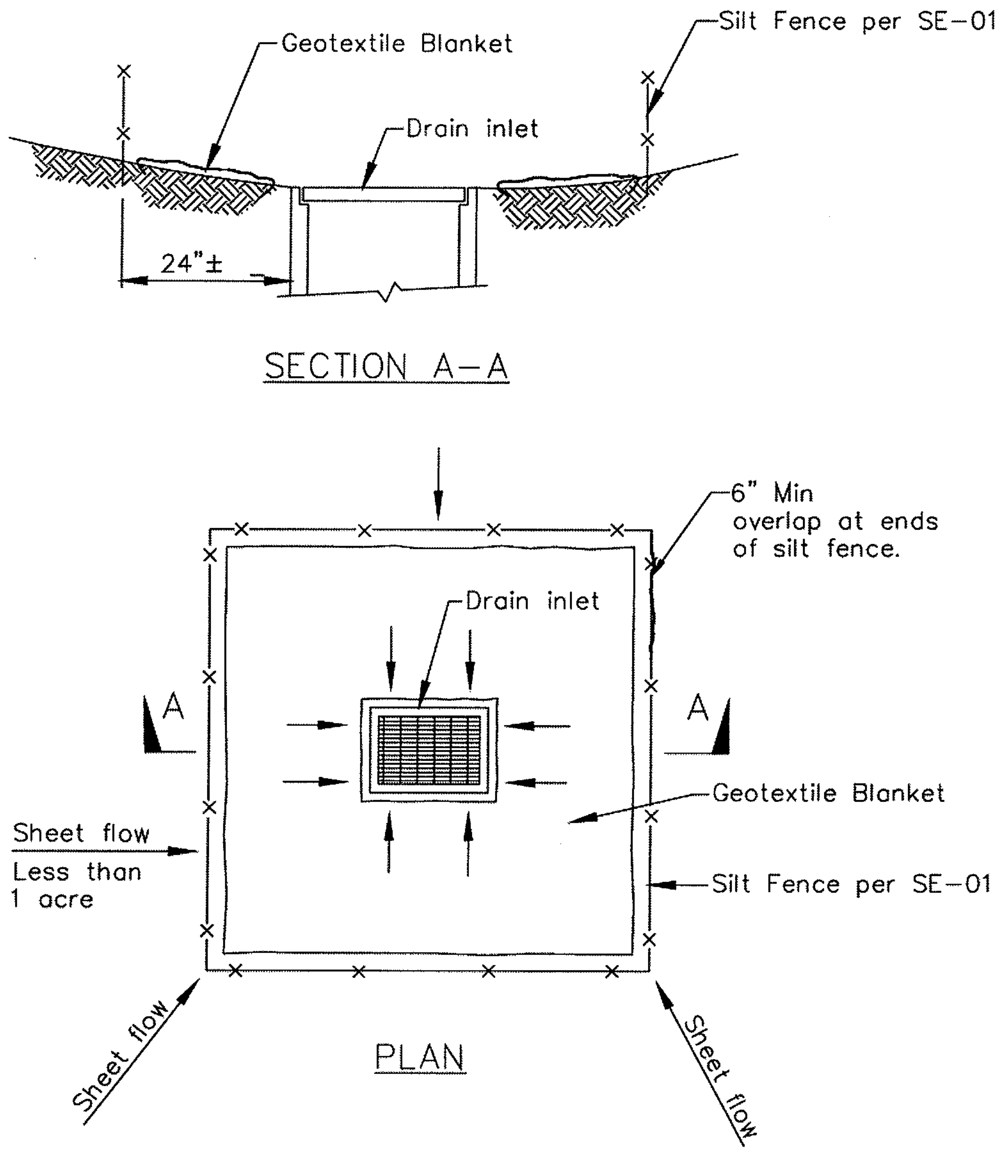
- Sediment that accumulates in the BMP must be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height. Sediment removed during maintenance may be incorporated into earthwork on the site ore disposed at an appropriate location.

- Remove storm drain inlet protection once the drainage area is stabilized.
  - Clean and regrade area around the inlet and clean the inside of the storm drain inlet as it must be free of sediment and debris at the time of final inspection.

References

Stormwater Quality Handbooks - Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

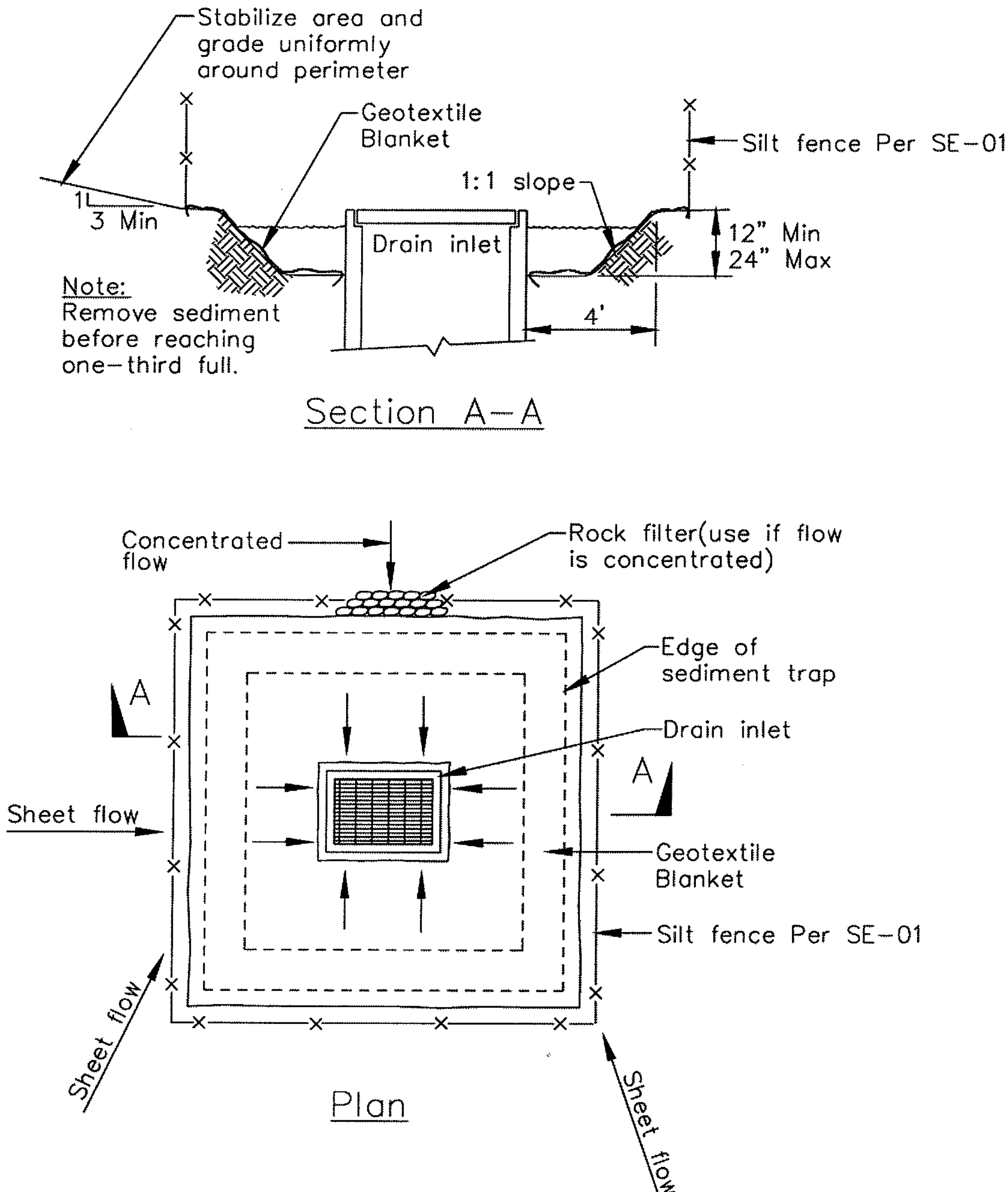
Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.



DI PROTECTION TYPE 1
NOT TO SCALE

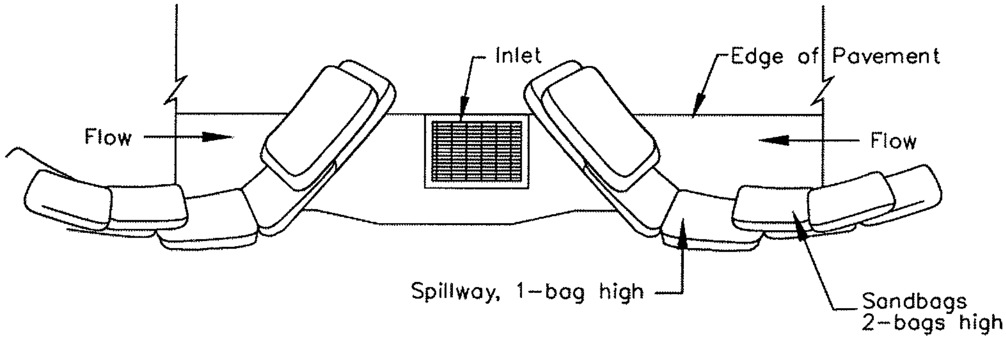
NOTES:

1. For use in areas where grading has been completed and final soil stabilization and seeding are pending.
2. Not applicable in paved areas.
3. Not applicable with concentrated flows.

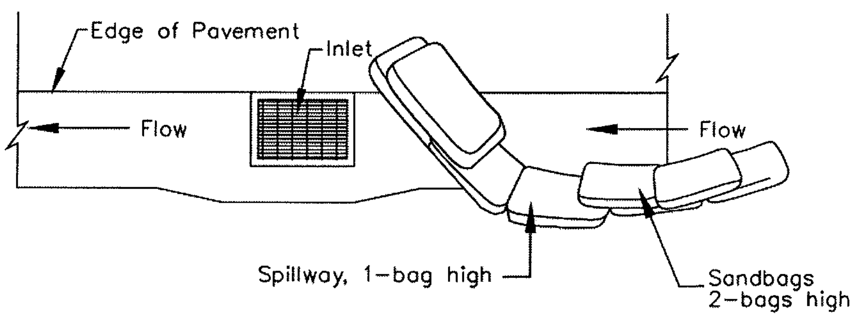


DI PROTECTION TYPE 2
NOT TO SCALE

Notes
1. For use in cleared and grubbed and in graded areas.
2. Shape basin so that longest inflow area faces longest length of trap.
3. For concentrated flows, shape basin in 2:1 ratio with length oriented towards direction of flow.



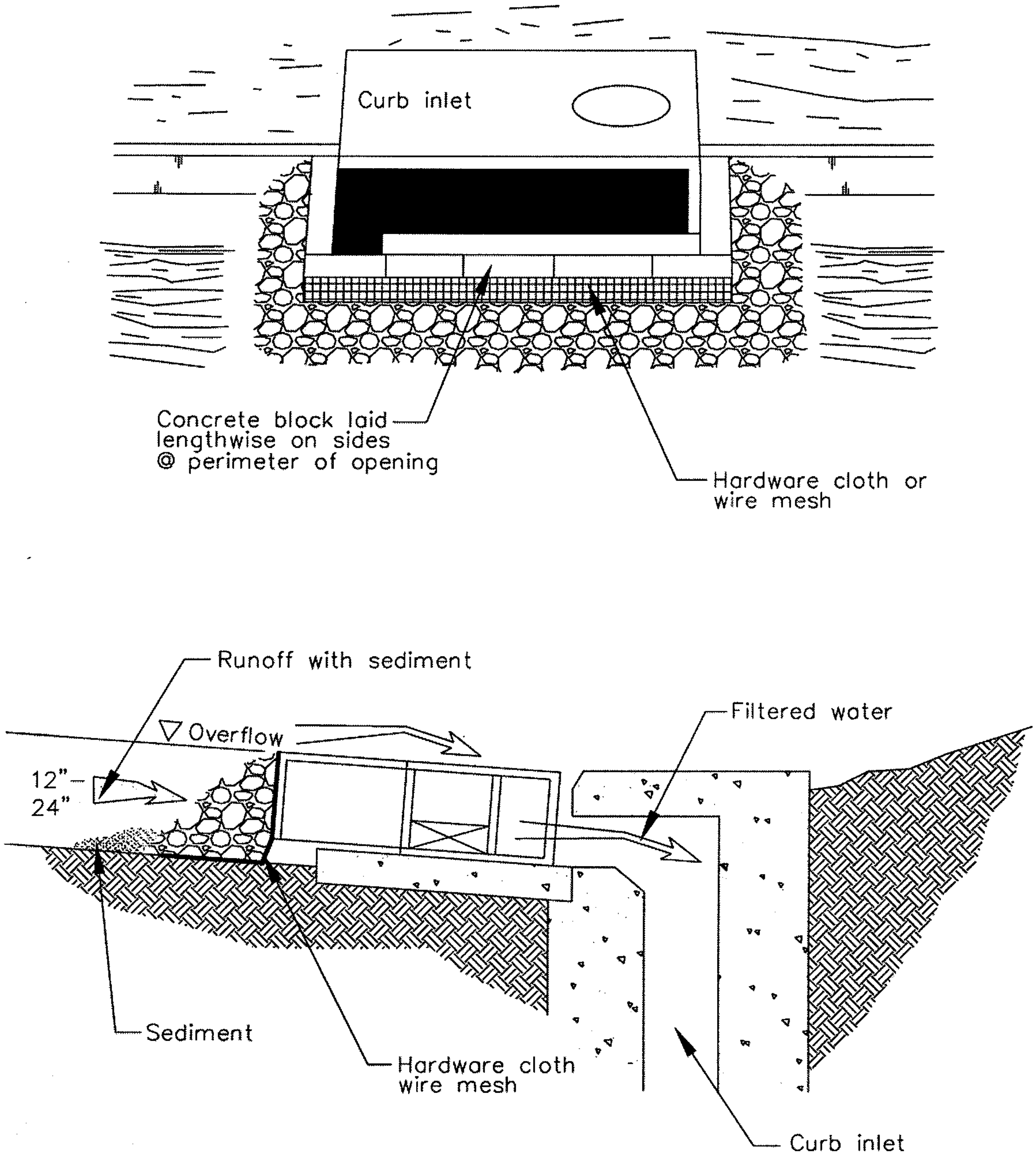
TYPICAL PROTECTION FOR INLET ON SUMP



TYPICAL PROTECTION FOR INLET ON GRADE

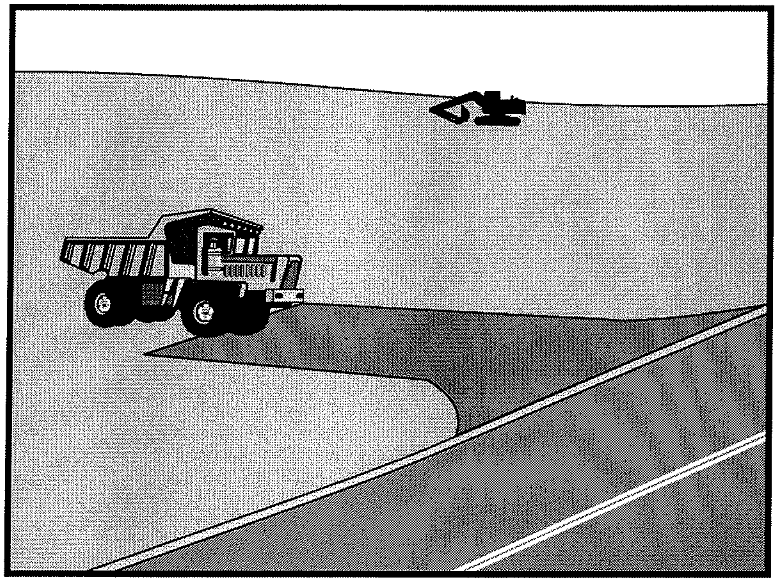
NOTES:
1. Intended for short-term use.
2. Use to inhibit non-storm water flow.
3. Allow for proper maintenance and cleanup.
4. Bags must be removed after adjacent operation is completed
5. Not applicable in areas with high silts and clays without filter fabric.

DI PROTECTION TYPE 3
NOT TO SCALE



DI PROTECTION – TYPE 4
NOT TO SCALE

Stabilized Construction Entrance/Exit TC-1



Objectives

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

A stabilized construction access is defined by a point of entrance/exit to a construction site that is stabilized to reduce the tracking of mud and dirt onto public roads by construction vehicles.

Suitable Applications

Use at construction sites:

- Where dirt or mud can be tracked onto public roads.
- Adjacent to water bodies.
- Where poor soils are encountered.
- Where dust is a problem during dry weather conditions.

Limitations

- Entrances and exits require periodic top dressing with additional stones.
- This BMP should be used in conjunction with street sweeping on adjacent public right of way.
- Entrances and exits should be constructed on level ground only.
- Stabilized construction entrances are rather expensive to construct and when a wash rack is included, a sediment trap of some kind must also be provided to collect wash water runoff.

Implementation

General

A stabilized construction entrance is a pad of aggregate underlain with filter cloth located at any point where traffic will be entering or leaving a construction site to or from a public right of way, street, alley, sidewalk, or parking area. The purpose of a stabilized construction entrance is to reduce or eliminate the tracking of sediment onto public rights of way or streets. Reducing tracking of sediments and other pollutants onto paved roads helps prevent deposition of sediments into local storm drains and production of airborne dust.

Where traffic will be entering or leaving the construction site, a stabilized construction entrance should be used. NPDES permits require that appropriate measures be implemented to prevent tracking of sediments onto paved roadways, where a significant source of sediments is derived from mud and dirt carried out from unpaved roads and construction sites.

Stabilized construction entrances are moderately effective in removing sediment from equipment leaving a construction site. The entrance should be built on level ground. Advantages of the Stabilized Construction Entrance/Exit is that it does remove some sediment from equipment and serves to channel construction traffic in and out of the site at specified locations. Efficiency is greatly increased when a washing rack is included as part of a stabilized construction entrance/exit.

Design and Layout

- Construct on level ground where possible.
- Select 3 to 6 in. diameter stones.
- Use minimum depth of stones of 12 in. or as recommended by soils engineer.
- Construct length of 50 ft minimum, and 30 ft minimum width.
- Rumble racks constructed of steel panels with ridges and installed in the stabilized entrance/exit will help remove additional sediment and to keep adjacent streets clean.
- Provide ample turning radii as part of the entrance.
- Limit the points of entrance/exit to the construction site.
- Limit speed of vehicles to control dust.
- Properly grade each construction entrance/exit to prevent runoff from leaving the construction site.
- Route runoff from stabilized entrances/exits through a sediment trapping device before discharge.
- Design stabilized entrance/exit to support heaviest vehicles and equipment that will use it.
- Select construction access stabilization (aggregate, asphaltic concrete, concrete) based on longevity, required performance, and site conditions. Do not use asphalt concrete (AC) grindings for stabilized construction access/roadway.

- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth, or place aggregate to a depth recommended by a geotechnical engineer. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.
- Designate combination or single purpose entrances and exits to the construction site.
- Require that all employees, subcontractors, and suppliers utilize the stabilized construction access.
- Implement SE-7, Street Sweeping and Vacuuming, as needed.
- All exit locations intended to be used for more than a two-week period should have stabilized construction entrance/exit BMPs.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMPs are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect local roads adjacent to the site daily. Sweep or vacuum to remove visible accumulated sediment.
- Remove aggregate, separate and dispose of sediment if construction entrance/exit is clogged with sediment.
- Keep all temporary roadway ditches clear.
- Check for damage and repair as needed.
- Replace gravel material when surface voids are visible.
- Remove all sediment deposited on paved roadways within 24 hours.
- Remove gravel and filter fabric at completion of construction

Costs

Average annual cost for installation and maintenance may vary from $1,200 to $4,800 each, averaging $2,400 per entrance. Costs will increase with addition of washing rack, and sediment trap. With wash rack, costs range from $1,200 - $6,000 each, averaging $3,600 per entrance.

References

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

National Management Measures to Control Nonpoint Source Pollution from Urban Areas, USEPA Agency, 2002.

Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters, Work Group Working Paper, USEPA, April 1992.

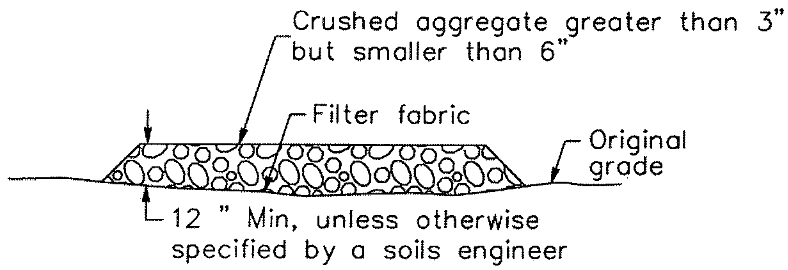
Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

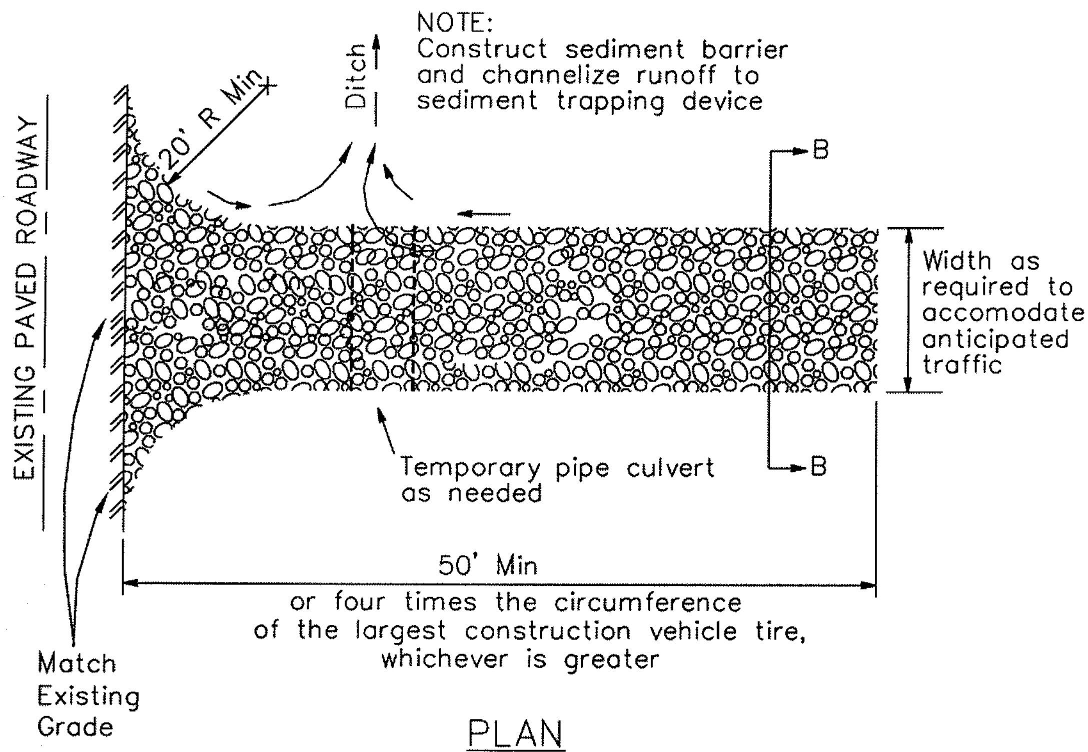
Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Guidance Specifying Management Measures for Nonpoint Pollution in Coastal Waters, EPA 840-B-9-002, USEPA, Office of Water, Washington, DC, 1993.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

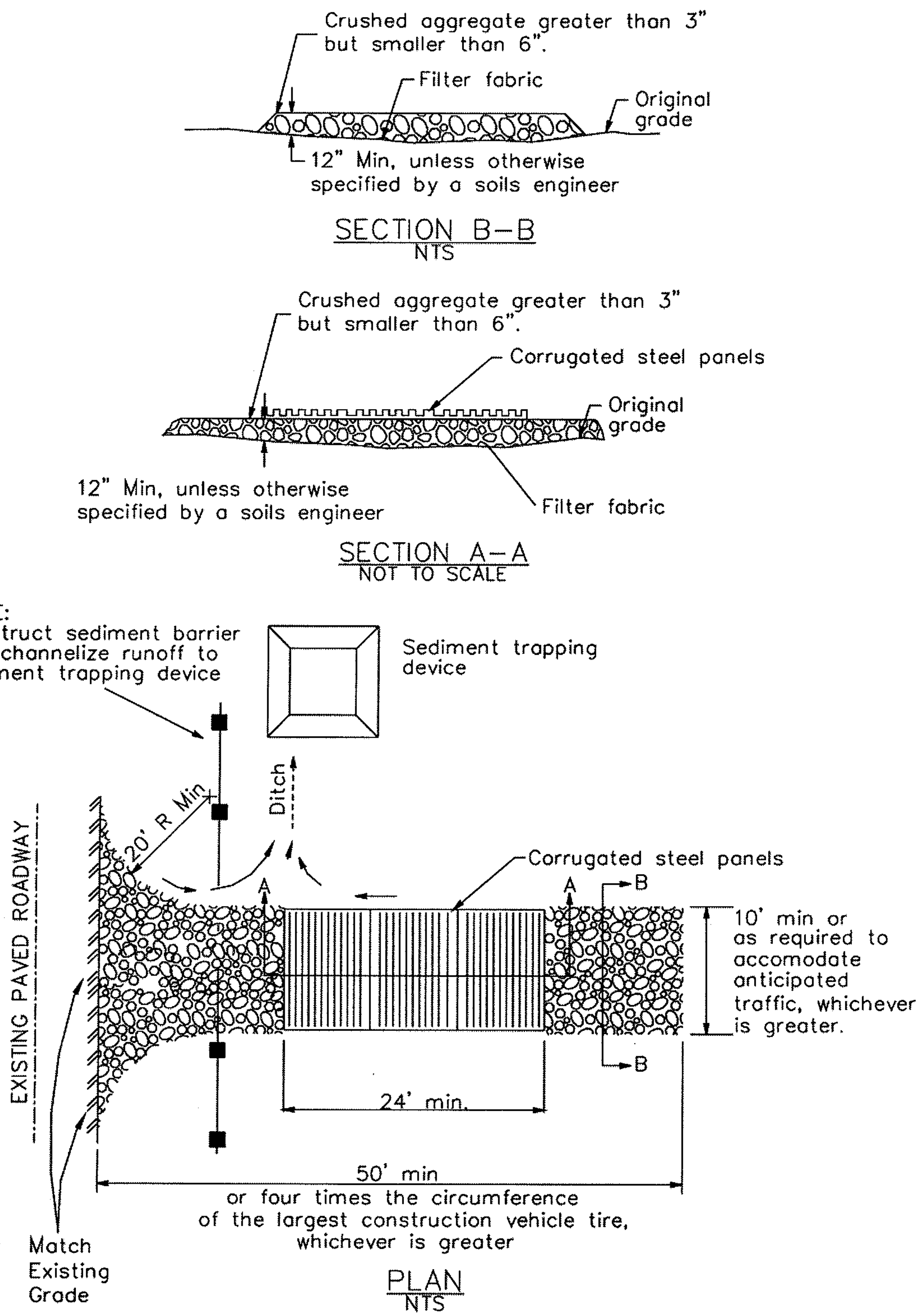


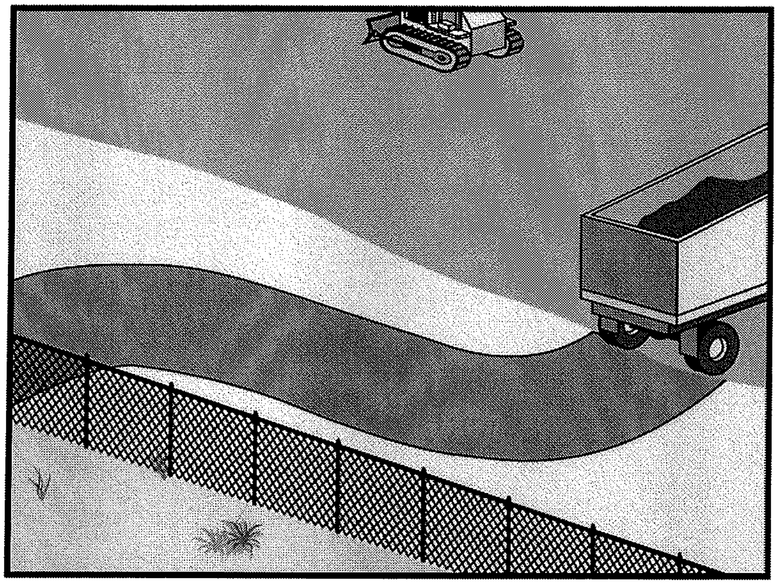
SECTION B-B
NTS



PLAN
NTS

Stabilized Construction Entrance/Exit TC-1





Objectives

EC	Erosion Control	☒
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

Description and Purpose

Access roads, subdivision roads, parking areas, and other onsite vehicle transportation routes should be stabilized immediately after grading, and frequently maintained to prevent erosion and control dust.

Suitable Applications

This BMP should be applied for the following conditions:

- Temporary Construction Traffic:
  - Phased construction projects and offsite road access
  - Construction during wet weather
- Construction roadways and detour roads:
  - Where mud tracking is a problem during wet weather
  - Where dust is a problem during dry weather
  - Adjacent to water bodies
  - Where poor soils are encountered

Limitations

- The roadway must be removed or paved when construction is complete.

- Certain chemical stabilization methods may cause stormwater or soil pollution and should not be used. See WE-1, Wind Erosion Control.
- Management of construction traffic is subject to air quality control measures. Contact the local air quality management agency.
- Materials will likely need to be removed prior to final project grading and stabilization.
- Use of this BMP may not be applicable to very short duration projects.

Implementation

General

Areas that are graded for construction vehicle transport and parking purposes are especially susceptible to erosion and dust. The exposed soil surface is continually disturbed, leaving no opportunity for vegetative stabilization. Such areas also tend to collect and transport runoff waters along their surfaces. During wet weather, they often become muddy quagmires that generate significant quantities of sediment that may pollute nearby streams or be transported offsite on the wheels of construction vehicles. Dirt roads can become so unstable during wet weather that they are virtually unusable.

Efficient construction road stabilization not only reduces onsite erosion but also can significantly speed onsite work, avoid instances of immobilized machinery and delivery vehicles, and generally improve site efficiency and working conditions during adverse weather

Installation/Application Criteria

Permanent roads and parking areas should be paved as soon as possible after grading. As an alternative where construction will be phased, the early application of gravel or chemical stabilization may solve potential erosion and stability problems. Temporary gravel roadway should be considered during the rainy season and on slopes greater than 5%.

Temporary roads should follow the contour of the natural terrain to the maximum extent possible. Slope should not exceed 15%. Roadways should be carefully graded to drain transversely. Provide drainage swales on each side of the roadway in the case of a crowned section or one side in the case of a super elevated section. Simple gravel berms without a trench can also be used.

Installed inlets should be protected to prevent sediment laden water from entering the storm sewer system (SE-10, Storm Drain Inlet Protection). In addition, the following criteria should be considered.

- Road should follow topographic contours to reduce erosion of the roadway.
- The roadway slope should not exceed 15%.
- Chemical stabilizers or water are usually required on gravel or dirt roads to prevent dust (WE-1, Wind Erosion Control).
- Properly grade roadway to prevent runoff from leaving the construction site.
- Design stabilized access to support heaviest vehicles and equipment that will use it.

- Stabilize roadway using aggregate, asphalt concrete, or concrete based on longevity, required performance, and site conditions. The use of cold mix asphalt or asphalt concrete (AC) grindings for stabilized construction roadway is not allowed.

- Coordinate materials with those used for stabilized construction entrance/exit points.

- If aggregate is selected, place crushed aggregate over geotextile fabric to at least 12 in. depth. A crushed aggregate greater than 3 in. but smaller than 6 in. should be used.

Inspection and Maintenance

- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, impact weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.

- Keep all temporary roadway ditches clear.

- When no longer required, remove stabilized construction roadway and re-grade and repair slopes.

- Periodically apply additional aggregate on gravel roads.

- Active dirt construction roads are commonly watered three or more times per day during the dry season.

Costs

Gravel construction roads are moderately expensive, but cost is often balanced by reductions in construction delay. No additional costs for dust control on construction roads should be required above that needed to meet local air quality requirements.

References

Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

Stormwater Quality Handbooks Construction Site Best Management Practices (BMPs) Manual, State of California Department of Transportation (Caltrans), November 2000.

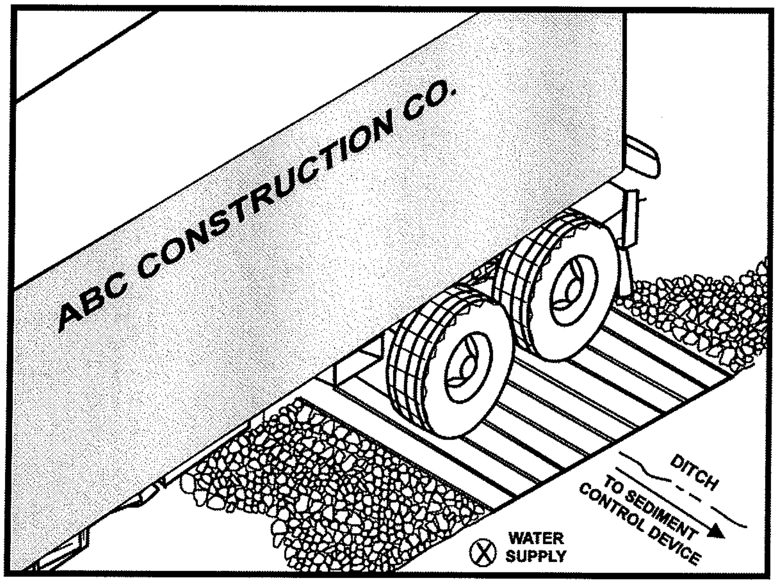
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Stormwater Management of the Puget Sound Basin, Technical Manual, Publication #91-75, Washington State Department of Ecology, February 1992.

Virginia Erosion and Sedimentation Control Handbook, Virginia Department of Conservation and Recreation, Division of Soil and Water Conservation, 1991.

Water Quality Management Plan for the Lake Tahoe Region, Volume II, Handbook of Management Practices, Tahoe Regional Planning Agency, November 1988.

Entrance/Outlet Tire Wash



Objectives

EC	Erosion Control	
SE	Sediment Control	☒
TC	Tracking Control	☑
WE	Wind Erosion Control	
NS	Non-Stormwater Management Control	
WM	Waste Management and Materials Pollution Control	

Legend:

☑ **Primary Objective**

☒ **Secondary Objective**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

TC-1 Stabilized Construction Entrance/Exit

Description and Purpose

A tire wash is an area located at stabilized construction access points to remove sediment from tires and under carriages and to prevent sediment from being transported onto public roadways.

Suitable Applications

Tire washes may be used on construction sites where dirt and mud tracking onto public roads by construction vehicles may occur.

Limitations

- The tire wash requires a supply of wash water.
- A turnout or doublewide exit is required to avoid having entering vehicles drive through the wash area.
- Do not use where wet tire trucks leaving the site leave the road dangerously slick.

Implementation

- Incorporate with a stabilized construction entrance/exit. See TC-1, Stabilized Construction Entrance/Exit.
- Construct on level ground when possible, on a pad of coarse aggregate greater than 3 in. but smaller than 6 in. A geotextile fabric should be placed below the aggregate.
- Wash rack should be designed and constructed/manufactured for anticipated traffic loads.

CASQA
CALIFORNIA STORMWATER QUALITY ASSOCIATION

- Provide a drainage ditch that will convey the runoff from the wash area to a sediment trapping device. The drainage ditch should be of sufficient grade, width, and depth to carry the wash runoff.
- Use hoses with automatic shutoff nozzles to prevent hoses from being left on.
- Require that all employees, subcontractors, and others that leave the site with mud caked tires and undercarriages to use the wash facility.
- Implement SC-7, Street Sweeping and Vacuuming, as needed.

Costs
Costs are low for installation of wash rack.

Inspection and Maintenance
- Inspect and verify that activity–based BMPs are in place prior to the commencement of associated activities. While activities associated with the BMP are under way, inspect weekly during the rainy season and of two-week intervals in the non-rainy season to verify continued BMP implementation.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.
- Remove accumulated sediment in wash rack and/or sediment trap to maintain system performance.
- Inspect routinely for damage and repair as needed.

References
Blueprint for a Clean Bay: Best Management Practices to Prevent Stormwater Pollution from Construction Related Activities; Santa Clara Valley Nonpoint Source Pollution Control Program, 1995.

Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

Manual of Standards of Erosion and Sediment Control Measures, Association of Bay Area Governments, May 1995.

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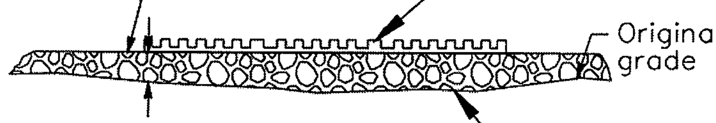
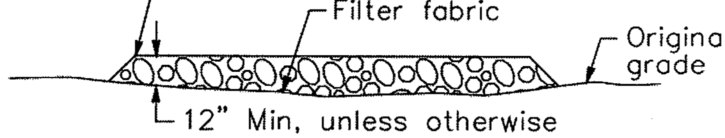
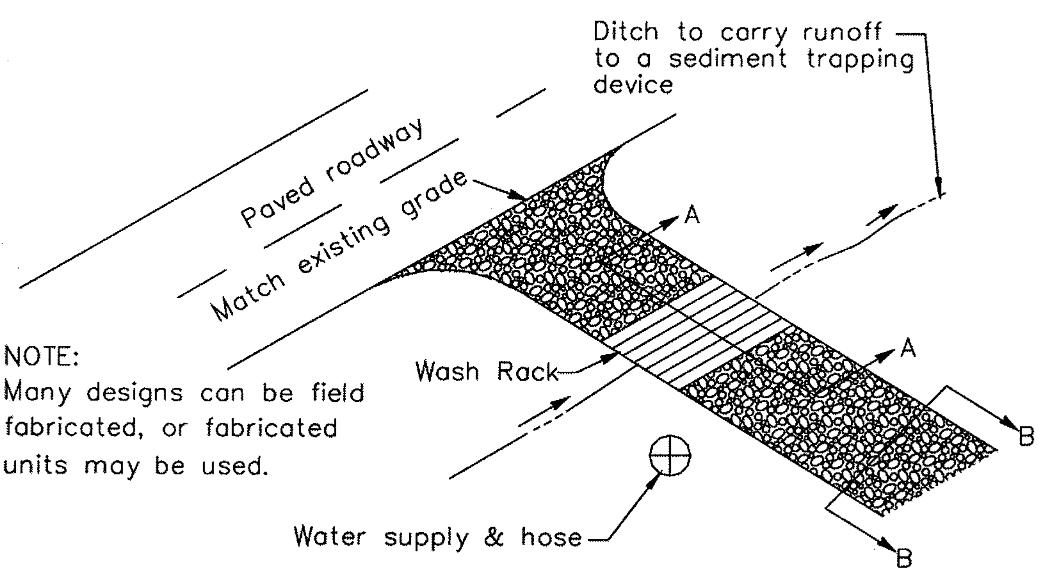
Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.



SECTION A–A
NOT TO SCALE



SECTION B–B
NTS



NOTE:
Many designs can be field fabricated, or fabricated units may be used.

TYPICAL TIRE WASH
NOT TO SCALE

ATTACHMENT 2

COLUSA GENERATING STATION
COLS-1-DC-024-0001

RATIONAL METHOD TABLES

Table RO-2—Conveyance Coefficient, C_v

Type of Land Surface	Conveyance Coefficient, C_v
Heavy meadow	2.5
Tillage/field	5
Short pasture and lawns	7
Nearly bare ground	10
Grassed waterway	15
Paved areas and shallow paved swales	20

Table RO-3—Recommended Percentage Imperviousness Values

Land Use or Surface Characteristics	Percentage Imperviousness
Business:	
Commercial areas	95
Neighborhood areas	85
Residential:	
Single-family	*
Multi-unit (detached)	60
Multi-unit (attached)	75
Half-acre lot or larger	*
Apartments	80
Industrial:	
Light areas	80
Heavy areas	90
Parks, cemeteries	5
Playgrounds	10
Schools	50
Railroad yard areas	15
Undeveloped Areas:	
Historic flow analysis	2
Greenbelts, agricultural	2
Off-site flow analysis (when land use not defined)	45
Streets:	
Paved	100
Gravel (packed)	40
Drive and walks	90
Roofs	90
Lawns, sandy soil	0
Lawns, clayey soil	0

* See Figures RO-3 through RO-5 for percentage imperviousness.

$$C_A = K_A + \left(1.31i^3 - 1.44i^2 + 1.135i - 0.12\right) \text{ for } C_A \geq 0, \text{ otherwise } C_A = 0 \qquad \text{(RO-6)}$$

$$C_{CD} = K_{CD} + \left(0.858i^3 - 0.786i^2 + 0.774i + 0.04\right) \qquad \text{(RO-7)}$$

$$C_B = \left(C_A + C_{CD}\right)/2$$

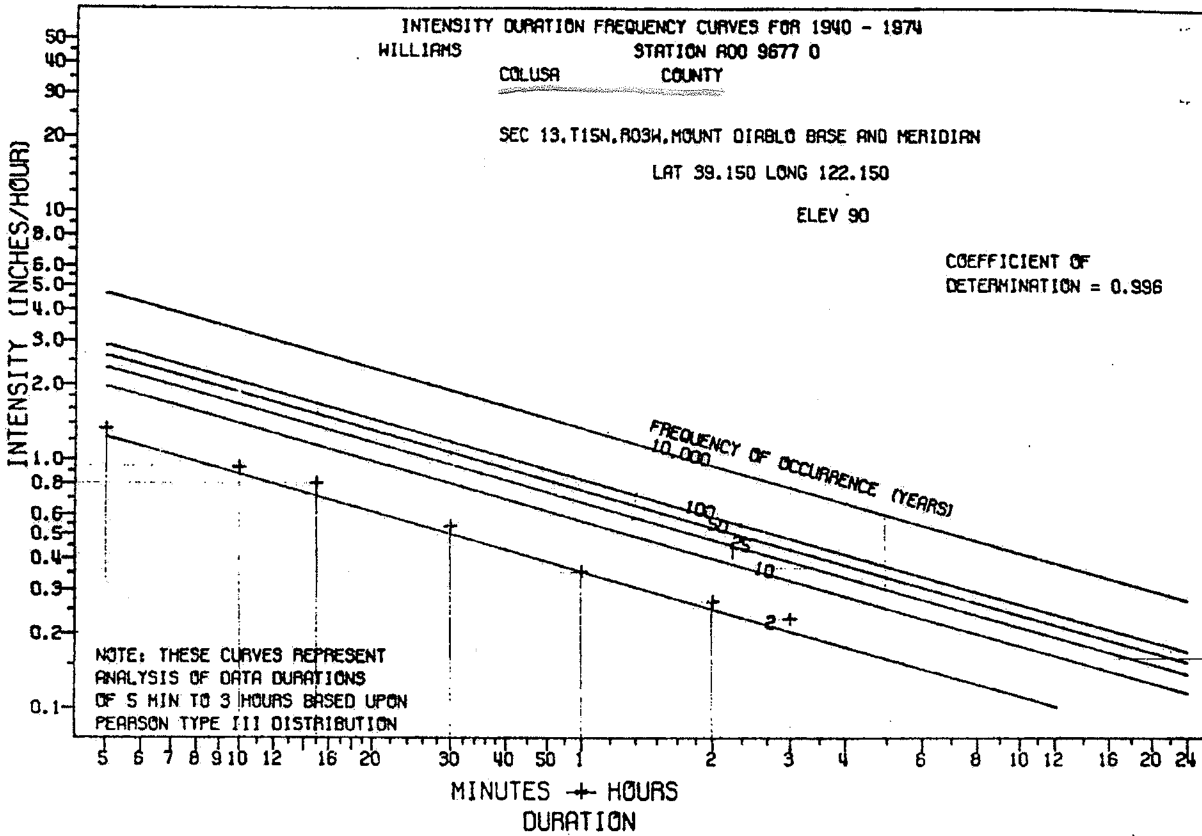
Table RO-5— Runoff Coefficients, *C*

Percentage Imperviousness	Type C and D NRCS Hydrologic Soil Groups					
	2-yr	5-yr	10-yr	25-yr	50-yr	100-yr
0%	0.04	0.15	0.25	0.37	0.44	0.50
5%	0.08	0.18	0.28	0.39	0.46	0.52
10%	0.11	0.21	0.30	0.41	0.47	0.53
15%	0.14	0.24	0.32	0.43	0.49	0.54
20%	0.17	0.26	0.34	0.44	0.50	0.55
25%	0.20	0.28	0.36	0.46	0.51	0.56
30%	0.22	0.30	0.38	0.47	0.52	0.57
35%	0.25	0.33	0.40	0.48	0.53	0.57
40%	0.28	0.35	0.42	0.50	0.54	0.58
45%	0.31	0.37	0.44	0.51	0.55	0.59
50%	0.34	0.40	0.46	0.53	0.57	0.60
55%	0.37	0.43	0.48	0.55	0.58	0.62
60%	0.41	0.46	0.51	0.57	0.60	0.63
65%	0.45	0.49	0.54	0.59	0.62	0.65
70%	0.49	0.53	0.57	0.62	0.65	0.68
75%	0.54	0.58	0.62	0.66	0.68	0.71
80%	0.60	0.63	0.66	0.70	0.72	0.74
85%	0.66	0.68	0.71	0.75	0.77	0.79
90%	0.73	0.75	0.77	0.80	0.82	0.83
95%	0.80	0.82	0.84	0.87	0.88	0.89
100%	0.89	0.90	0.92	0.94	0.95	0.96
	TYPE B NRCS HYDROLOGIC SOILS GROUP					
0%	0.02	0.08	0.15	0.25	0.30	0.35
5%	0.04	0.10	0.19	0.28	0.33	0.38
10%	0.06	0.14	0.22	0.31	0.36	0.40
15%	0.08	0.17	0.25	0.33	0.38	0.42
20%	0.12	0.20	0.27	0.35	0.40	0.44
25%	0.15	0.22	0.30	0.37	0.41	0.46
30%	0.18	0.25	0.32	0.39	0.43	0.47
35%	0.20	0.27	0.34	0.41	0.44	0.48
40%	0.23	0.30	0.36	0.42	0.46	0.50
45%	0.26	0.32	0.38	0.44	0.48	0.51
50%	0.29	0.35	0.40	0.46	0.49	0.52
55%	0.33	0.38	0.43	0.48	0.51	0.54
60%	0.37	0.41	0.46	0.51	0.54	0.56
65%	0.41	0.45	0.49	0.54	0.57	0.59
70%	0.45	0.49	0.53	0.58	0.60	0.62
75%	0.51	0.54	0.58	0.62	0.64	0.66
80%	0.57	0.59	0.63	0.66	0.68	0.70
85%	0.63	0.66	0.69	0.72	0.73	0.75
90%	0.71	0.73	0.75	0.78	0.80	0.81
95%	0.79	0.81	0.83	0.85	0.87	0.88
100%	0.89	0.90	0.92	0.94	0.95	0.96

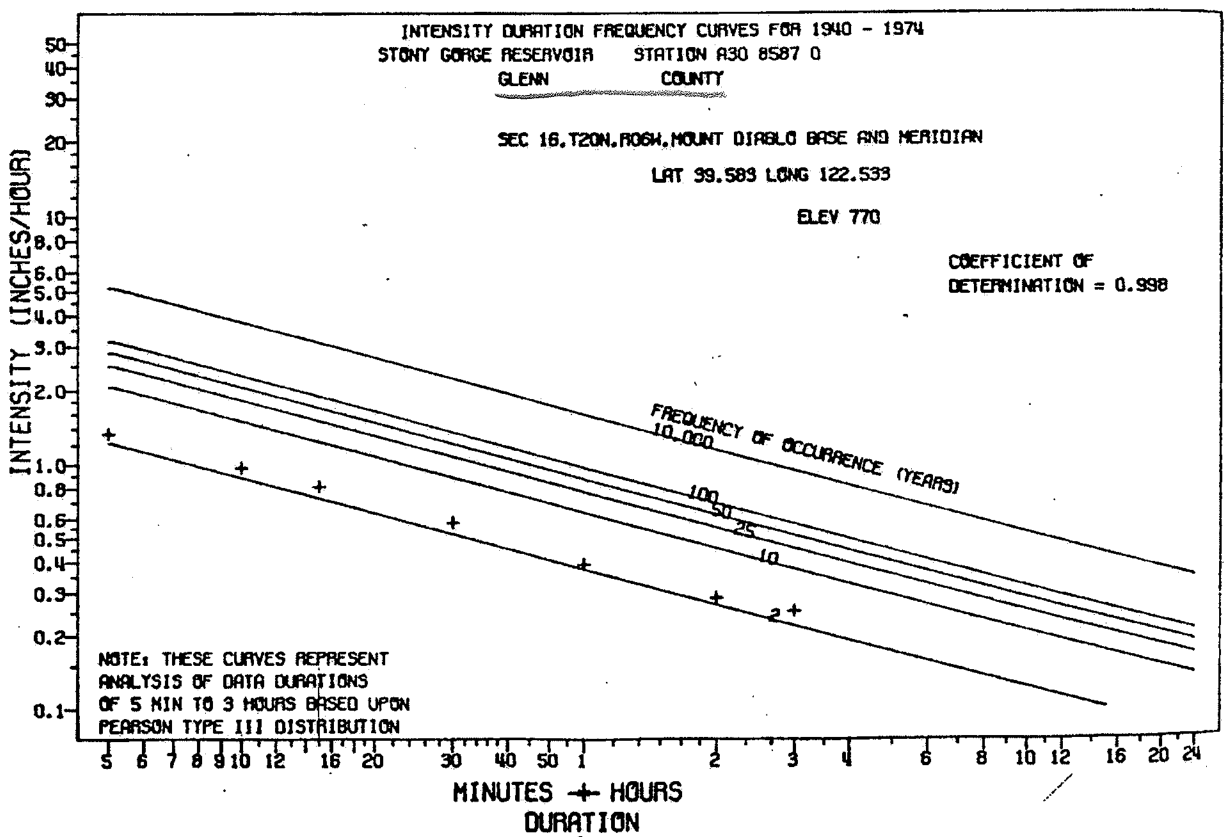
ATTACHMENT 3

COLUSA GENERATING STATION
COLS-1-DC-024-0001

INTENSITY DURATION FREQUENCY CURVES



INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1974
WILLIAMS
STATION A00 9677 0
COLUSA
COUNTY
SEC 13,T15N,R03W,MOUNT DIABLO BASE AND MERIDIAN
LAT 39.150 LONG 122.150
ELEV 90
COEFFICIENT OF DETERMINATION = 0.996
FREQUENCY OF OCCURRENCE (YEARS)
10,000
100
50
25
10
2
NOTE: THESE CURVES REPRESENT ANALYSIS OF DATA DURATIONS OF 5 MIN TO 3 HOURS BASED UPON PEARSON TYPE III DISTRIBUTION
INTENSITY (INCHES/HOUR)
MINUTES + HOURS
DURATION

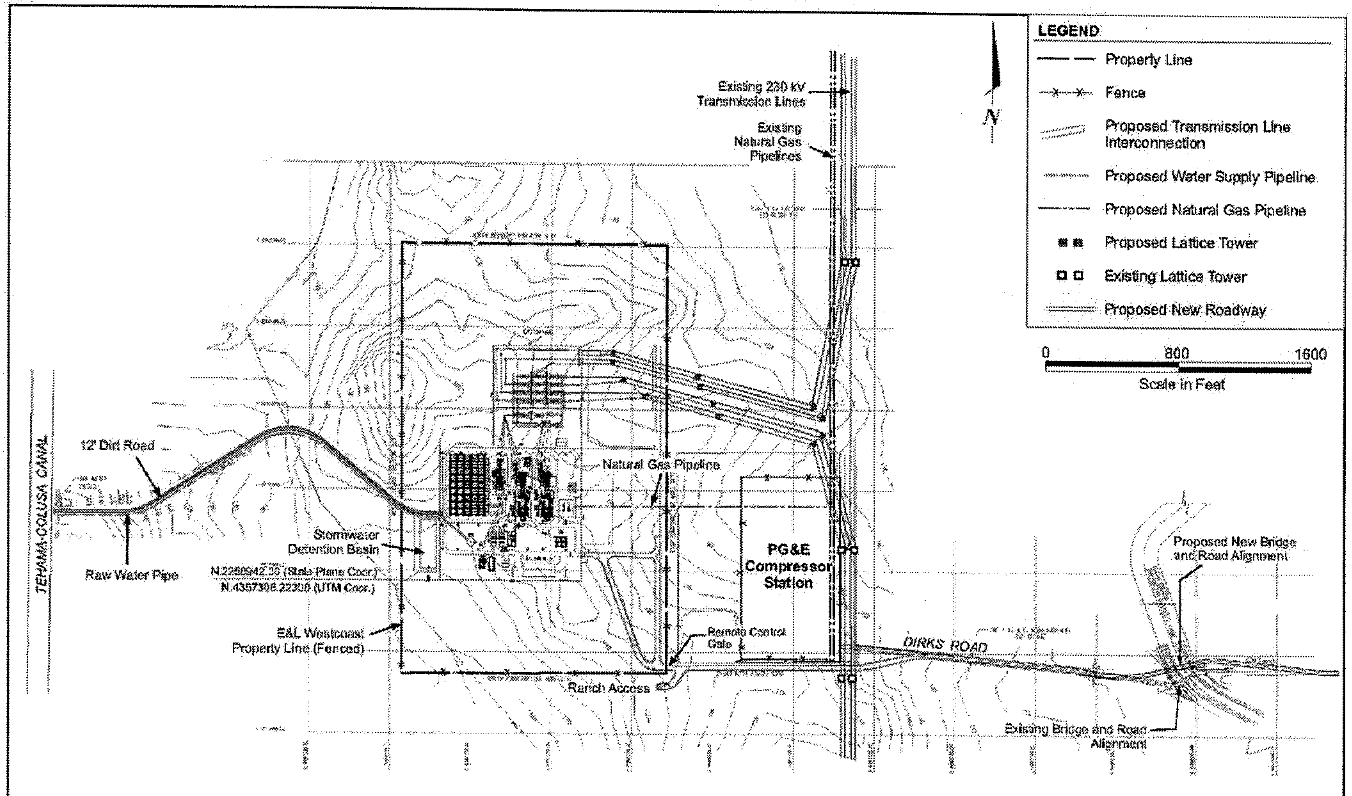


INTENSITY DURATION FREQUENCY CURVES FOR 1940 - 1974
STONY GORGE RESERVOIR
STATION A30 8587 0
GLENN
COUNTY
SEC 16,T20N,R06W,MOUNT DIABLO BASE AND MERIDIAN
LAT 39.583 LONG 122.533
ELEV 770
COEFFICIENT OF DETERMINATION = 0.998
FREQUENCY OF OCCURRENCE (YEARS)
10,000
100
50
25
10
2
NOTE: THESE CURVES REPRESENT ANALYSIS OF DATA DURATIONS OF 5 MIN TO 3 HOURS BASED UPON PEARSON TYPE III DISTRIBUTION
INTENSITY (INCHES/HOUR)
MINUTES + HOURS
DURATION

ATTACHMENT 4

COLUSA GENERATING STATION
COLS-1-DC-024-0001

PROPOSED PLANT AREA GENERAL ARRANGEMENT



Source:
Bechtel Corporation; Colusa Power Plant, Dwg. No. P1-0100-00003
General Arrangement With Air Cooled Condenser (COL_GA05 Rev Oc) October 4, 2006;
Figure 7.2-1 in progress Oct 20, 2006

28067004
November 2006

URS

SITE PLAN

Colusa Generating Station
E&L Westcoast, LLC
Colusa County, California

FIGURE 3.3-1

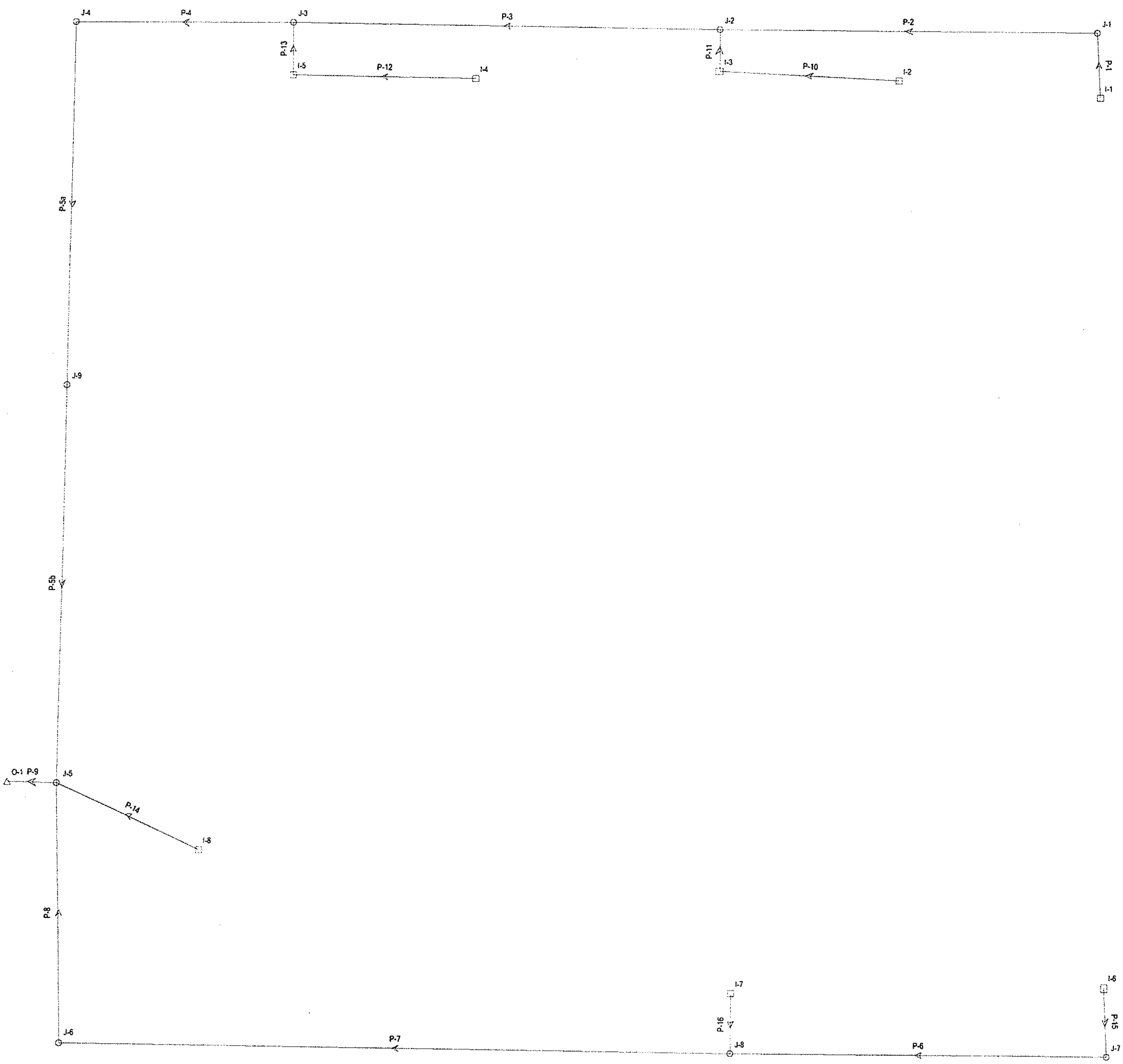
10/27/06 vsa ..\28067004 CPV Colusa\3.0 Facility Description\3.3-1_site plan.cdr

ATTACHMENT 5

COLUSA GENERATING STATION
COLS-1-DC-024-0001

DRAINAGE SYSTEM ARRANGEMENT

Scenario: Base



Title: Colusa Generating Station
y:\...\stormcad\colusa-100yr-storm-rev-1.stm
03/24/08 11:02:56 AM

WorleyParsons

Project Engineer: Trieu Hoang
StormCAD v5.6 [05.06.012.00]

ATTACHMENT 6

COLUSA GENERATING STATION
COLS-1-DC-024-0001

SITE SOIL MAP

Colusa Quadrangle
Soil Survey of Colusa County, CA

Source:
Soils Coverage: Soil Survey Geographic (SSURGO) Database, USDA - Natural Resources Conservation Service (NRCS)
MrSID: NRCS - National Cartographic & Geospatial Center
Projection: "Teale" Albers

1 0 1 Miles

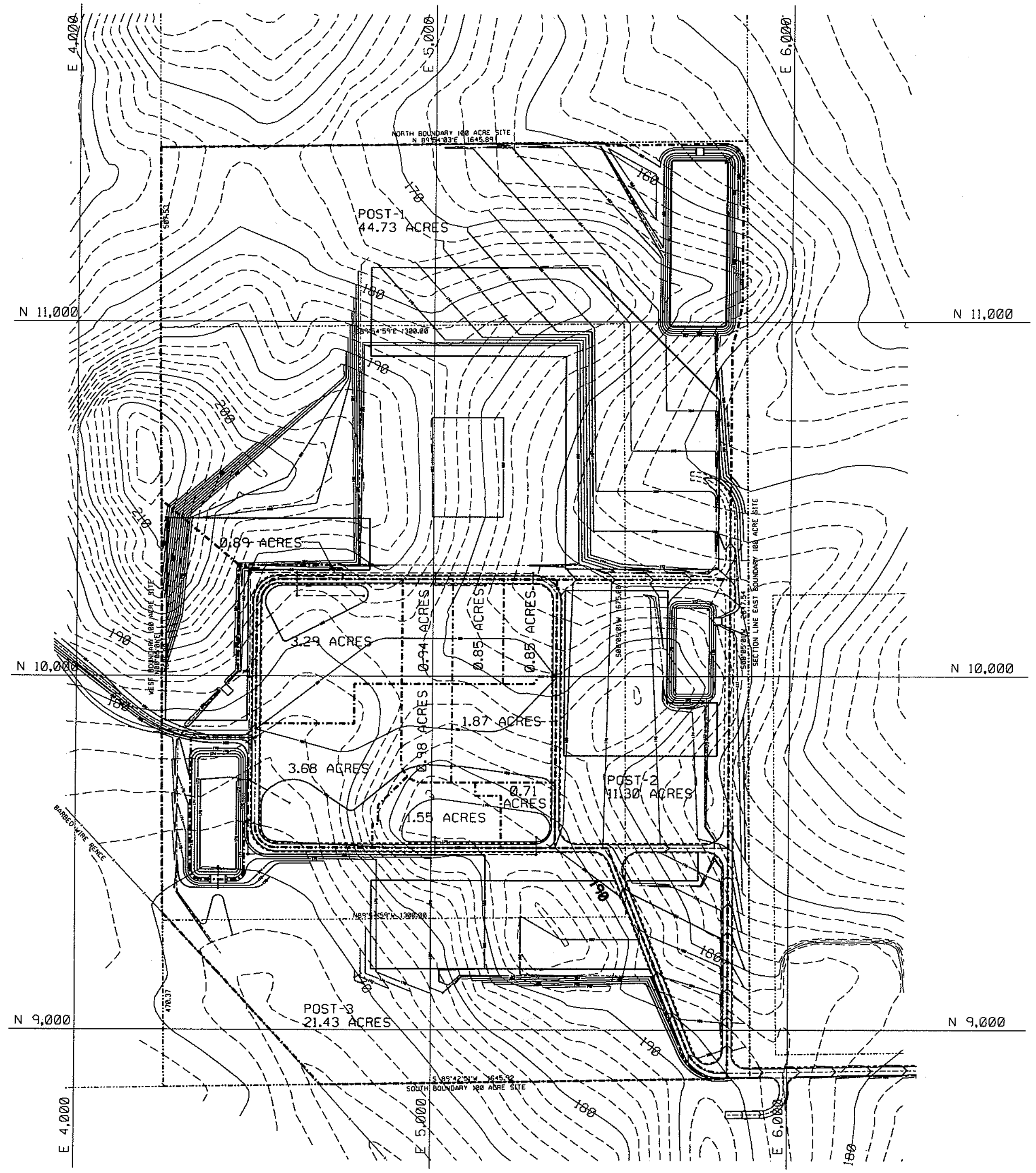
SCALE 1:62,500

N

ATTACHMENT 7

COLUSA GENERATING STATION
COLS-1-DC-024-0001

DRAINAGE AREA – POWER BLOCK & LAND POST-DEVELOPMENT



NOTES:

1. GRID SHOWN IS BASED ON THE COLUSA PLANT COORDINATE SYSTEM.
2. TOPOGRAPHY DATA PROVIDED BY GEMMA POWER SYSTEMS, LLC VIA ELECTRONIC MAIL ON DECEMBER 10, 2007. THE CAD FILES USED IN THE PREPARATION OF THIS PLAN WERE OBTAINED FROM CBCSURVEYS, SACRAMENTO, CA.
3. PROPERTY METES AND BOUNDS OBTAINED FROM THE TENTATIVE PARCEL MAP FOR LEO M. AND DIANE HOLTHOUSE DATED SEPTEMBER 7, 2007, PREPARED BY CBCSURVEYS, SACRAMENTO, CA.

LEGEND

180	EXISTING GRADE CONTOURS
	DRAINAGE BASIN LIMITS
	BOUNDARY LINE

200 0 200 400 600
SCALE IN FEET

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/ TECH. SPEC.	LEAD DISC ENGINEER	PROJ ENGR MANAGER	PROJECT MANAGER

PRELIMINARY STATUS DATE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.
LDE GD KISHIYAMA 03/24/08

APPROVED STATUS DATE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED "HOLD" RETAINS PRELIMINARY STATUS.
LDE

ORIGINATING PERSONNEL	PROFESSIONAL ENGINEER'S SEAL
DRAWN BY: CJH	
CHECKED BY	
LEAD DESIGNER: GJ UZAR	
ENGINEER/TECH SPECIALIST: T HOANG	
PROJECT ENGINEERING MANAGER	
PROJECT MANAGER	

Zero Harm — Leadership, No Incidents, Safe Behavior

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF
PE: ____ STATE: ____
LIC. NO.: ____ DATE: ____

WorleyParsons
resources & energy

Gemma Power Systems California, Inc.

Pacific Gas and Electric Company
COLUSA GENERATING STATION

POST DEVELOPMENT
DRAINAGE MAP

SCALE: 1"=200'
DRAWING SIZE: ARCH D (36" x 24")
WORLEYPARSONS DWG. NO.: COLS-1-SK-024-716-002
REV

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3/24/2008 11:39:50 AM

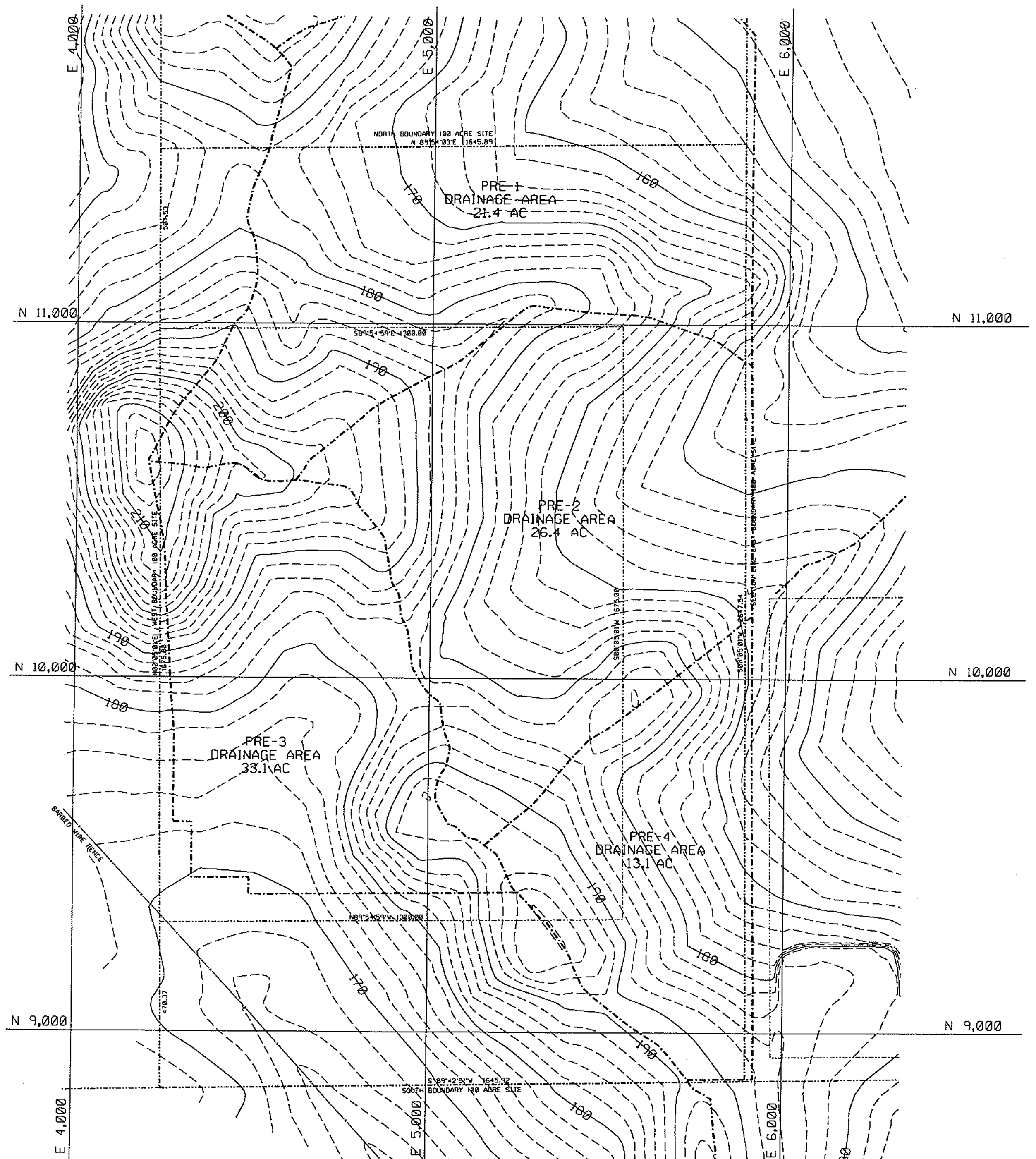
ATTACHMENT 8

COLUSA GENERATING STATION
COLS-1-DC-024-0001

DRAINAGE AREA – LAND PRE-DEVELOPMENT

NOTES:

1. GRID SHOWN IS BASED ON THE COLUSA PLANT COORDINATE SYSTEM.
2. TOPOGRAPHY DATA PROVIDED BY GEMMA POWER SYSTEMS, LLC VIA ELECTRONIC MAIL ON DECEMBER 10, 2007. THE CAD FILES USED IN THE PREPARATION OF THIS PLAN WERE OBTAINED FROM CBCSURVEYS, SACRAMENTO, CA.
3. PROPERTY METES AND BOUNDS OBTAINED FROM THE TENTATIVE PARCEL MAP FOR LEO M. AND DIANE HOLTHOUSE DATED SEPTEMBER 7, 2007, PREPARED BY CBCSURVEYS, SACRAMENTO, CA.



LEGEND

180	EXISTING GRADE CONTOURS
	EXISTING DRAINAGE BASIN LIMITS
	BOUNDARY LINE

200 0 200 400 600

SCALE IN FEET

REV	DATE	DESCRIPTION	DRAWN	CHECKED	LEAD DESIGNER	ENGINEER/TECH SPEC	LEAD DISC MANAGER	PROJ ENGR MANAGER	PROJECT MANAGER

PRELIMINARY STATUS DATE — REPRESENTS GENERAL DESIGN CONCEPTS BASED ON ASSUMPTIONS. REVIEWED NOT CHECKED.
LDE GD KISHIYAMA

APPROVED STATUS DATE — REPRESENTS REVIEWED AND APPROVED DESIGN. ANY PORTION MARKED 'HOLD' RETAINS PRELIMINARY STATUS.
LDE

ORIGINATING PERSONNEL | PROFESSIONAL ENGINEER'S SEAL

DRAWN BY: CJH
CHECKED BY:
LEAD DESIGNER: GJ UZAR
ENGINEER/TECH SPECIALIST: T HOANG
PROJECT ENGINEERING MANAGER: DM WITZEL
PROJECT MANAGER: MA GENCER

Zero Harm — Leadership, No Incidents, Safe Behavior

ORIGINALLY PREPARED UNDER THE RESPONSIBLE SUPERVISION OF
PE: STATE:
LIC. NO.: DATE:

WorleyParsons
resources & energy

Gemma
Gemma Power Systems California, Inc.

PG&E Pacific Gas and Electric Company
COLUSA GENERATING STATION

PRE-DEVELOPMENT
DRAINAGE MAP

SCALE: 1"=200'
DRAWING SIZE: ARCH D (36" x 24")
WORLEYPARSONS DWG. NO.: COLS-1-SK-024-716-001
REV:

ATTACHMENT 9

COLUSA GENERATING STATION
COLS-1-DC-024-0001

RUNOFF CALCULATIONS – POWER BLOCK

COLUSA GENERATING STATION

Runoff Calculations
(by Rational Method)

100-yr Storm Event:

Imperviousness =	0.9	*(From Table RO-3, Urban Drainage and Flood Control District, Volume 1)*
C_{100} =	0.83	*(From Table RO-5, Urban Drainage and Flood Control District, Volume 1)*
C_v =	20	*(From Table RO-2, Urban Drainage and Flood Control District, Volume 1)*

Inlet	A (acres)	L (ft)	S (ft/ft)	T_i (min)	T_t (min)	Initial T_c (min)	T_c Check (min)	Final T_c (min)	I (in/hr)	Q (cfs)	Q_{total} (cfs)
I-1	0.85	210	0.010	7.06	1.75	8.81	11.17	8.81	2.50	1.76	1.76
I-2	0.85	235	0.010	7.47	1.96	9.43	11.31	9.43	2.30	1.62	1.62
I-3 (land)	0.94	240	0.010	7.55	2.00	9.55	11.33	9.55	2.30	1.79	
I-3 (pipe)	----------	----------	should be equal Q_{I-2}						------------>	1.62	3.42
I-4	1.64	250	0.010	7.71	2.08	9.79	11.39	9.79	2.20	2.99	2.99
I-5 (land)	2.53	340	0.010	8.99	2.83	11.82	11.89	11.82	2.10	4.41	
I-5 (pipe)	----------	----------	should be equal Q_{I-4}			----------	----------	----------	------------>	2.99	7.40
I-6 (land)	0.71	220	0.010	7.23	1.83	9.06	11.22	9.06	2.20	1.30	
I-6 (swale)	2.85	560	0.005	14.50	6.60	21.10	13.11	13.11	1.90	4.49	5.79
I-7	1.55	200	0.010	6.89	1.67	8.56	11.11	8.56	2.50	3.22	3.22
I-8	3.68	460	0.010	10.46	3.83	14.29	12.56	12.56	2.05	6.26	6.26
								Total Intercepted Flow (cfs) =			32.47

A	=	*Area*
L	=	*Length*
S	=	*Slope*
T_i	=	$(0.395*(1.1-C_{100})*(L^{0.5})) \div (S^{0.33})$
T_t	=	$L \div (60*C_v*S^{0.5})$
Initial T_c	=	$T_i + T_t$
T_c Check	=	$(L \div 180) + 10$
Final T_c	=	*Smaller between Initial T_c and T_c Check*
I	=	*From Intensity Duration Frequency Curves for 1940-1974, Glenn County*
Q	=	$C_{100} * I * A$

COLUSA GENERATING STATION

Runoff Calculations
(by Rational Method)

10-yr Storm Event:

Imperviousness = 0.9 *(From Table RO-3, Urban Drainage and Flood Control District, Volume 1)*
C_{10} = 0.77 *(From Table RO-5, Urban Drainage and Flood Control District, Volume 1)*
C_v = 20 *(From Table RO-2, Urban Drainage and Flood Control District, Volume 1)*

Inlet	A (acres)	L (ft)	S (ft/ft)	T_i (min)	T_t (min)	Initial T_c (min)	T_c Check (min)	Final T_c (min)	I (in/hr)	Q (cfs)	Q_{total} (cfs)
I-1	0.85	210	0.010	8.63	1.75	10.38	11.17	10.38	1.50	0.98	0.98
I-2	0.85	235	0.010	9.13	1.96	11.09	11.31	11.09	1.40	0.92	0.92
I-3 (land)	0.94	240	0.010	9.23	2.00	11.23	11.33	11.23	1.35	0.98	
I-3 (pipe)	----------	---------- should be equal Q_{I-2}							--------->	0.92	1.89
I-4	1.64	250	0.010	9.42	2.08	11.50	11.39	11.39	1.35	1.70	1.70
I-5 (land)	2.53	340	0.010	10.99	2.83	13.82	11.89	11.89	1.35	2.63	
I-5 (pipe)	----------	---------- should be equal Q_{I-4} ----------							--------->	1.70	4.33
I-6 (land)	0.71	220	0.010	8.84	1.83	10.67	11.22	10.67	1.45	0.79	
I-6 (swale)	2.85	560	0.005	17.72	6.60	24.32	13.11	13.11	1.30	2.85	3.65
I-7	1.55	200	0.010	8.43	1.67	10.09	11.11	10.09	1.50	1.79	1.79
I-8	3.68	460	0.010	12.78	3.83	16.61	12.56	12.56	1.35	3.83	3.83
								Total Intercepted Flow (cfs) =			19.09

A = *Area*
L = *Length*
S = *Slope*
T_i = $(0.395*(1.1-C_{10})*(L^{0.5})) \div (S^{0.33})$
T_t = $L \div (60*C_v*S^{0.5})$
Initial T_c = $T_i + T_t$
T_c Check = $(L \div 180) + 10$
Final T_c = *Smaller between Initial T_c and T_c Check*
I = *From Intensity Duration Frequency Curves for 1940-1974, Glenn County*
Q = $C_{10} * I * A$

COLUSA GENERATING STATION

Runoff Calculations
(by Rational Method)

2-yr Storm Event:

Imperviousness =	0.9	*(From Table RO-3, Urban Drainage and Flood Control District, Volume 1)*
C_2 =	0.73	*(From Table RO-5, Urban Drainage and Flood Control District, Volume 1)*
C_v =	20	*(From Table RO-2, Urban Drainage and Flood Control District, Volume 1)*

Inlet	A (acres)	L (ft)	S (ft/ft)	T_i (min)	T_t (min)	Initial T_c (min)	T_c Check (min)	Final T_c (min)	I (in/hr)	Q (cfs)	Q_{total} (cfs)
I-1	0.85	210	0.010	9.68	1.75	11.43	11.17	11.17	0.85	0.53	0.53
I-2	0.85	235	0.010	10.24	1.96	12.20	11.31	11.31	0.80	0.50	0.50
I-3 (land)	0.94	240	0.010	10.35	2.00	12.35	11.33	11.33	0.80	0.55	
I-3 (pipe)	----------	----------	should be equal Q_{I-2}						------------>	0.50	1.05
I-4	1.64	250	0.010	10.56	2.08	12.65	11.39	11.39	0.80	0.96	0.96
I-5 (land)	2.53	340	0.010	12.32	2.83	15.15	11.89	11.89	0.80	1.48	
I-5 (pipe)	----------	----------	should be equal Q_{I-4}			----------	----------	----------	------------>	0.96	2.44
I-6 (land)	0.71	220	0.010	9.91	1.83	11.74	11.22	11.22	0.85	0.44	
I-6 (swale)	2.85	560	0.005	19.87	6.60	26.47	13.11	13.11	0.75	1.56	2.00
I-7	1.55	200	0.010	9.45	1.67	11.11	11.11	11.11	0.85	0.96	0.96
I-8	3.68	460	0.010	14.33	3.83	18.16	12.56	12.56	0.80	2.15	2.15
								Total Intercepted Flow (cfs) =			**10.57**

A	=	*Area*
L	=	*Length*
S	=	*Slope*
T_i	=	$(0.395*(1.1-C_2)*(L^{0.5})) \div (S^{0.33})$
T_t	=	$L \div (60*C_v*S^{0.5})$
Initial T_c	=	$T_i + T_t$
T_c *Check*	=	$(L \div 180) + 10$
Final T_c	=	*Smaller between Initial* T_c *and* T_c *Check*
I	=	*From Intensity Duration Frequency Curves for 1940-1974, Glenn County*
Q	=	$C_2 * I * A$

ATTACHMENT 10

COLUSA GENERATING STATION
COLS-1-DC-024-0001

RUNOFF CALCULATIONS – LAND PRE-DEVELOPMENT

COLUSA GENERATING STATION

Runoff Calculations
(by Rational Method)

Historic 100-yr Storm Event:

Imperviousness =	0.45	*(From Table RO-3, Urban Drainage and Flood Control District, Volume 1)*
C_{100} =	0.59	*(From Table RO-5, Urban Drainage and Flood Control District, Volume 1)*
C_v =	7	*(From Table RO-2, Urban Drainage and Flood Control District, Volume 1)*

Drainage Area	A (acres)	L_O (ft)	L_C (ft)	S_O (ft/ft)	S_C (ft/ft)	T_i (min)	T_t (min)	Initial T_c (min)	T_c Check (min)	Final T_c (min)	I (in/hr)	Q (cfs)
PRE-1	21.4	280	1200	0.061	0.033	8.50	15.85	24.35	18.22	18.22	1.70	21.46
PRE-2	26.4	500	850	0.036	0.029	13.49	11.80	25.29	14.72	14.72	1.95	30.37
PRE-3	33.1	400	1700	0.063	0.016	10.06	32.51	42.57	19.44	19.44	1.60	31.25
PRE-4	13.1	250	500	0.020	0.044	11.58	5.68	17.26	12.78	12.78	2.10	16.23
Total												**99.31**

A	=	*Area*
L_O	=	*Overland Length*
L_C	=	*Chanelized Length*
S_O	=	*Overland Slope*
S_C	=	*Chanelized Slope*
T_i	=	$(0.395*(1.1-C_{100})*(L_O^{0.5})) \div (S_O^{0.33})$
T_t	=	$L_C \div (60*C_v*S_C^{0.5})$
Initial T_c	=	$T_i + T_t$
T_c Check	=	$((L_O+L_C)\div 180) + 10$
Final T_c	=	*Smaller between Initial T_c and T_c Check*
I	=	*From Intensity Duration Frequency Curves for 1940-1974, Glenn County*
Q	=	$C_{100} * I * A$

COLUSA GENERATING STATION

Runoff Calculations
(by Rational Method)

Historic 10-yr Storm Event:

Imperviousness =	0.45	*(From Table RO-3, Urban Drainage and Flood Control District, Volume 1)*
C_{10} =	0.44	*(From Table RO-5, Urban Drainage and Flood Control District, Volume 1)*
C_v =	7	*(From Table RO-2, Urban Drainage and Flood Control District, Volume 1)*

Drainage Area	***A*** (acres)	L_O (ft)	L_C (ft)	S_O (ft/ft)	S_C (ft/ft)	T_i (min)	T_t (min)	***Initial*** T_c (min)	T_c ***Check*** (min)	***Final*** T_c (min)	***I*** (in/hr)	***Q*** (cfs)
PRE-1	21.4	280	1200	0.061	0.033	11.00	15.85	26.85	18.22	18.22	1.10	10.36
PRE-2	26.4	500	850	0.036	0.029	17.46	11.80	29.26	14.72	14.72	1.20	13.94
PRE-3	33.1	400	1700	0.063	0.016	13.02	32.51	45.53	19.44	19.44	1.10	16.02
PRE-4	13.1	250	500	0.020	0.044	14.99	5.68	20.66	12.78	12.78	1.35	7.78
Total												**48.10**

A	=	*Area*
L_O	=	*Overland Length*
L_C	=	*Chanelized Length*
S_O	=	*Overland Slope*
S_C	=	*Chanelized Slope*
T_i	=	$(0.395*(1.1-C_{10})*(L_O^{0.5})) \div (S_O^{0.33})$
T_t	=	$L_C \div (60*C_v*S_C^{0.5})$
Initial T_c	=	$T_i + T_t$
T_c *Check*	=	$((L_O+L_C)\div 180) + 10$
Final T_c	=	*Smaller between Initial* T_c *and* T_c *Check*
I	=	*From Intensity Duration Frequency Curves for 1940-1974, Glenn County*
Q	=	$C_{10} * I * A$

COLUSA GENERATING STATION

Runoff Calculations
(by Rational Method)

Historic 2-yr Storm Event:

Imperviousness =	0.45	*(From Table RO-3, Urban Drainage and Flood Control District, Volume 1)*
C_2 =	0.31	*(From Table RO-5, Urban Drainage and Flood Control District, Volume 1)*
C_v =	7	*(From Table RO-2, Urban Drainage and Flood Control District, Volume 1)*

Drainage Area	***A*** *(acres)*	***L_O*** *(ft)*	***L_C*** *(ft)*	***S_O*** *(ft/ft)*	***S_C*** *(ft/ft)*	***T_i*** *(min)*	***T_t*** *(min)*	***Initial T_c*** *(min)*	***T_c Check*** *(min)*	***Final T_c*** *(min)*	***I*** *(in/hr)*	***Q*** *(cfs)*
PRE-1	21.4	280	1200	0.061	0.033	13.16	15.85	29.01	18.22	18.22	0.65	4.31
PRE-2	26.4	500	850	0.036	0.029	20.90	11.80	32.70	14.72	14.72	0.75	6.14
PRE-3	33.1	400	1700	0.063	0.016	15.58	32.51	48.09	19.44	19.44	0.60	6.16
PRE-4	13.1	250	500	0.020	0.044	17.94	5.68	23.62	12.78	12.78	0.80	3.25
Total												**19.86**

A	=	*Area*
L_O	=	*Overland Length*
L_C	=	*Chanelized Length*
S_O	=	*Overland Slope*
S_C	=	*Chanelized Slope*
T_i	=	$(0.395*(1.1-C_2)*(L_O^{0.5})) \div (S_O^{0.33})$
T_t	=	$L_C \div (60*C_v*S_C^{0.5})$
Initial T_c	=	$T_i + T_t$
T_c Check	=	$((L_O+L_C)\div 180) + 10$
Final T_c	=	*Smaller between Initial T_c and T_c Check*
I	=	*From Intensity Duration Frequency Curves for 1940-1974, Glenn County*
Q	=	$C_2 * I * A$

ATTACHMENT 11

COLUSA GENERATING STATION
COLS-1-DC-024-0001

RUNOFF CALCULATIONS – LAND POST-DEVELOPMENT

COLUSA GENERATING STATION

Runoff Calculations
(by Rational Method)

Post-Development 100-yr Storm Event:

Imperviousness =	0.45	*(From Table RO-3, Urban Drainage and Flood Control District, Volume 1)*
C_{100} =	0.59	*(From Table RO-5, Urban Drainage and Flood Control District, Volume 1)*
C_v =	7	*(From Table RO-2, Urban Drainage and Flood Control District, Volume 1)*

Drainage Area	A (acres)	L_O (ft)	L_C (ft)	S_O (ft/ft)	S_C (ft/ft)	T_i (min)	T_t (min)	Initial T_c (min)	T_c Check (min)	Final T_c (min)	I (in/hr)	Q (cfs)
POST-1	44.7	360	1480	0.061	0.028	9.61	20.91	30.52	20.22	20.22	1.60	42.20
POST-2	11.3	180	420	0.022	0.029	9.50	5.91	15.41	12.33	12.33	2.20	14.67
POST-3	21.4	480	1220	0.058	0.017	11.28	22.55	33.82	16.78	16.78	1.80	22.73
Total												79.59

A	=	*Area*
L_O	=	*Overland Length*
L_C	=	*Chanelized Length*
S_O	=	*Overland Slope*
S_C	=	*Chanelized Slope*
T_i	=	$(0.395*(1.1-C_{100})*(L_O^{0.5})) \div (S_O^{0.33})$
T_t	=	$L_C \div (60*C_v*S_C^{0.5})$
Initial T_c	=	$T_i + T_t$
T_c Check	=	$((L_O+L_C)\div 180) + 10$
Final T_c	=	*Smaller between Initial T_c and T_c Check*
I	=	*From Intensity Duration Frequency Curves for 1940-1974, Glenn County*
Q	=	$C_{100} * I * A$

COLUSA GENERATING STATION

Runoff Calculations
(by Rational Method)

Post-Development 10-yr Storm Event:

Imperviousness = 0.45 *(From Table RO-3, Urban Drainage and Flood Control District, Volume 1)*
C_{10} = 0.44 *(From Table RO-5, Urban Drainage and Flood Control District, Volume 1)*
C_v = 7 *(From Table RO-2, Urban Drainage and Flood Control District, Volume 1)*

Drainage Area	A (acres)	L_O (ft)	L_C (ft)	S_O (ft/ft)	S_C (ft/ft)	T_i (min)	T_t (min)	Initial T_c (min)	T_c Check (min)	Final T_c (min)	I (in/hr)	Q (cfs)
POST-1	44.7	360	1480	0.061	0.028	12.44	20.91	33.35	20.22	20.22	1.15	22.62
POST-2	11.3	180	420	0.022	0.029	12.29	5.91	18.20	12.33	12.33	1.40	6.96
POST-3	21.4	480	1220	0.058	0.017	14.59	22.55	37.14	16.78	16.78	1.20	11.30
Total												40.88

A = *Area*
L_O = *Overland Length*
L_C = *Chanelized Length*
S_O = *Overland Slope*
S_C = *Chanelized Slope*
T_i = $(0.395*(1.1-C_{10})*(L_O^{0.5})) \div (S_O^{0.33})$
T_t = $L_C \div (60*C_v*S_C^{0.5})$
Initial T_c = $T_i + T_t$
T_c Check = $((L_O+L_C)\div 180) + 10$
Final T_c = *Smaller between Initial T_c and T_c Check*
I = *From Intensity Duration Frequency Curves for 1940-1974, Glenn County*
Q = $C_{10} * I * A$

COLUSA GENERATING STATION

Runoff Calculations
(by Rational Method)

Post-Development 2-yr Storm Event:

Imperviousness = 0.45 *(From Table RO-3, Urban Drainage and Flood Control District, Volume 1)*
C_2 = 0.31 *(From Table RO-5, Urban Drainage and Flood Control District, Volume 1)*
C_v = 7 *(From Table RO-2, Urban Drainage and Flood Control District, Volume 1)*

Drainage Area	A (acres)	L_O (ft)	L_C (ft)	S_O (ft/ft)	S_C (ft/ft)	T_i (min)	T_t (min)	Initial T_c (min)	T_c Check (min)	Final T_c (min)	I (in/hr)	Q (cfs)
POST-1	44.7	360	1480	0.061	0.028	14.89	20.91	35.80	20.22	20.22	0.60	8.31
POST-2	11.3	180	420	0.022	0.029	14.71	5.91	20.62	12.33	12.33	0.80	2.80
POST-3	21.4	480	1220	0.058	0.017	17.47	22.55	40.01	16.78	16.78	0.70	4.64
Total												15.76

A = *Area*
L_O = *Overland Length*
L_C = *Chanelized Length*
S_O = *Overland Slope*
S_C = *Chanelized Slope*
T_i = $(0.395*(1.1-C_2)*(L_O^{0.5})) \div (S_O^{0.33})$
T_t = $L_C \div (60*C_v*S_C^{0.5})$
Initial T_c = $T_i + T_t$
T_c Check = $((L_O+L_C)\div 180) + 10$
Final T_c = *Smaller between Initial T_c and T_c Check*
I = *From Intensity Duration Frequency Curves for 1940-1974, Glenn County*
Q = $C_2 * I * A$

ATTACHMENT 12

COLUSA GENERATING STATION
COLS-1-DC-024-0001

CATCH BASIN, MANHOLE, AND PIPE SCHEDULE

STORM SEWER STRUCTURE SCHEDULE							
No.	COORDINATE		TOP	INV IN	INV IN	INV IN	INV OUT
	NORTH	EAST					
I-1	10247	5280	180.0				177.26 P-1
J-1	10292	5280	181.0			176.99 P-1	176.99 P-2
I-2	10257	5145	180.0				176.50 P-10
I-3	10257	5005	180.0			175.80 P-10	175.80 P-11
J-2	10292	5005	181.0		175.59 P-2	175.59 P-11	175.59 P-3
I-4	10227	4803	180.0				177.14 P-12
I-5	10227	4813	179.0			175.81 P-12	175.81 P-13
J-3	10292	4613	181.0		173.59 P-3	173.59 P-13	173.59 P-4
J-4	10292	4493	181.0			172.90 P-4	172.90 P-5A
J-5	9706.5	4483	180.0	170.10 P-5B	170.10 P-8	170.10 P-14	170.10 P-9
OF-1	9706.5	4463				169.70 P-9	169.70
I-8	9641.5	4598	179.0				174.24 P-14
J-6	9496.5	4493	180.0			171.23 P-7	171.23 P-8
J-8	9496.5	5010	180.0		173.97 P-6	173.97 P-16	173.97 P-7
I-7	9546.5	5010	178.0				174.52 P-16
J-7	9496.5	5295	180.0			175.46 P-15	175.46 P-6
I-6	9546.5	5295	178.5				175.74 P-15
J-9	9997	4483	181.0			171.65 P-5A	171.65 P-5B

STORM SEWER PIPE SCHEDULE				
No.	SIZE	LENGTH	SLOPE	MATERIAL
P-1	12"	46'	0.0060	SLPE
P-2	15"	275'	0.0051	SLPE
P-3	24"	392'	0.0051	SLPE
P-4	30"	130'	0.0053	SLPE
P-5A	30"	295'	0.0047	SLPE
P-5B	30"	290.5'	0.0050	SLPE
P-6	24"	295'	0.0052	SLPE
P-7	24"	527'	0.0052	SLPE
P-8	30"	210'	0.0054	SLPE
P-9	36"	30'	0.0130	SLPE
P-10	15"	140'	0.0050	SLPE
P-11	18"	36'	0.0061	SLPE
P-12	18"	190'	0.0070	SLPE
P-13	24"	65'	0.0341	SLPE
P-14	24"	132'	0.0314	SLPE
P-15	18"	50'	0.0056	SLPE
P-16	18"	50'	0.0109	SLPE

SLPE - SMOOTH LINED POLYETHYLENE PIPE

ATTACHMENT 13

COLUSA GENERATING STATION
COLS-1-DC-024-0001

StormCAD CALCULATION RESULTS SUMMARY

Calculation Results Summary

100-year Storm

Scenario: Base

\>>>> Info: Subsurface Network Rooted by: O-1
\>>>> Info: Subsurface Analysis iterations: 1
\>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
I-8	Generic Inlet	Generic Default 100%	6.26	0.00	100.0	0.00	0.00
I-6	Generic Inlet	Generic Default 100%	5.79	0.00	100.0	0.00	0.00
I-7	Generic Inlet	Generic Default 100%	3.22	0.00	100.0	0.00	0.00
I-1	Generic Inlet	Generic Default 100%	1.76	0.00	100.0	0.00	0.00
I-3	Generic Inlet	Generic Default 100%	3.42	0.00	100.0	0.00	0.00
I-2	Generic Inlet	Generic Default 100%	1.62	0.00	100.0	0.00	0.00
I-5	Generic Inlet	Generic Default 100%	7.40	0.00	100.0	0.00	0.00
I-4	Generic Inlet	Generic Default 100%	2.99	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P-9	1	36 inch	Circular	20.00	32.46	14.65	171.55	170.09
P-14	1	24 inch	Circular	132.00	6.26	8.42	174.89	172.49
P-8	1	30 inch	Circular	210.00	9.01	4.93	172.58	172.49
P-5b	1	30 inch	Circular	290.50	17.19	5.58	173.04	172.49
P-7	1	24 inch	Circular	527.00	9.01	4.74	174.97	172.72
P-5a	1	30 inch	Circular	295.00	17.19	5.40	174.34	173.04
P-16	1	18 inch	Circular	50.00	3.22	6.27	175.68	175.38
P-6	1	18 inch	Circular	285.00	5.79	4.21	176.49	175.38
P-4	1	30 inch	Circular	130.00	17.19	5.67	175.24	175.02
P-15	1	18 inch	Circular	50.00	5.79	4.45	176.98	176.82
P-13	1	24 inch	Circular	65.00	10.39	9.04	176.55	175.71
P-3	1	24 inch	Circular	392.00	6.80	4.42	176.68	175.71
P-12	1	18 inch	Circular	190.00	2.99	3.64	177.44	177.27
P-2	1	15 inch	Circular	275.00	1.76	3.15	177.78	177.05
P-11	1	18 inch	Circular	35.00	5.04	4.25	177.13	177.05
P-1	1	12 inch	Circular	45.00	1.76	3.47	178.22	177.97
P-10	1	15 inch	Circular	140.00	1.62	3.22	177.52	177.42

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1	32.46	173.70	168.70	168.70
J-5	32.46	180.00	172.49	171.55
I-8	6.26	179.00	175.39	174.89
J-6	9.01	180.00	172.72	172.58
J-9	17.19	181.00	173.04	173.04

J-8	9.01	180.00	175.38	174.97
J-4	17.19	181.00	175.02	174.34
I-7	3.22	178.00	176.08	175.68
J-7	5.79	180.00	176.82	176.49
J-3	17.19	181.00	175.71	175.24
I-6	5.79	178.50	177.33	176.98
I-5	10.39	179.00	177.27	176.55
J-2	6.80	181.00	177.05	176.68
I-4	2.99	180.00	177.59	177.44
J-1	1.76	181.00	177.97	177.78
I-3	5.04	180.00	177.42	177.13
I-1	1.76	180.00	178.50	178.22
I-2	1.62	180.00	177.69	177.52

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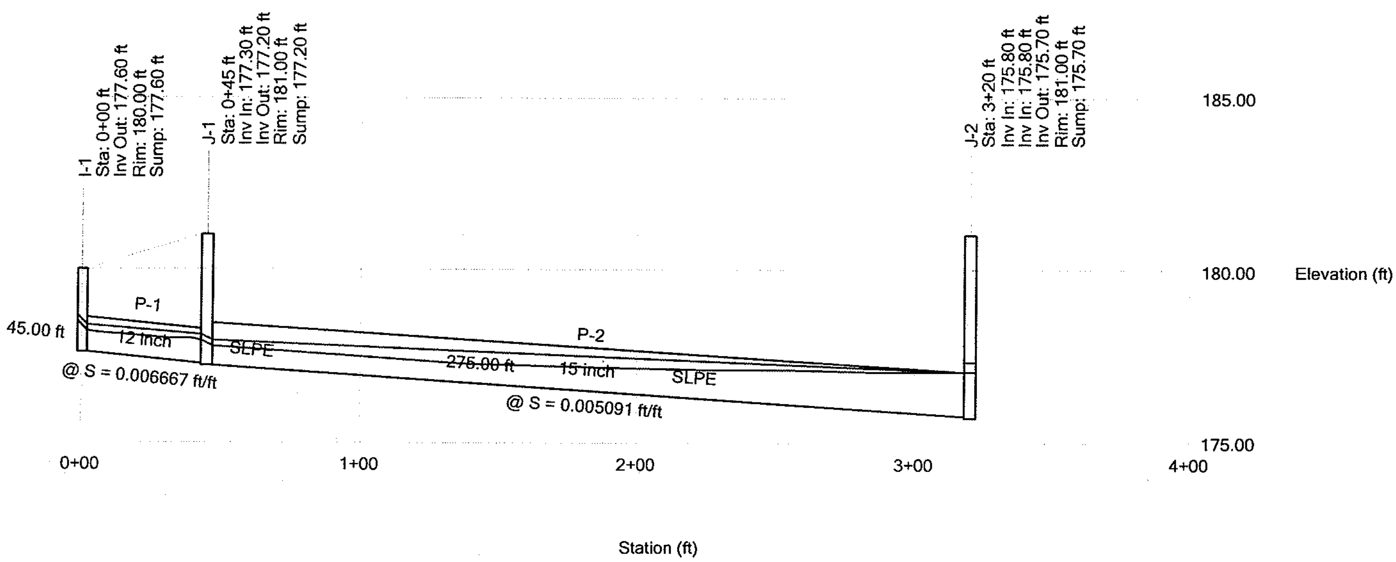
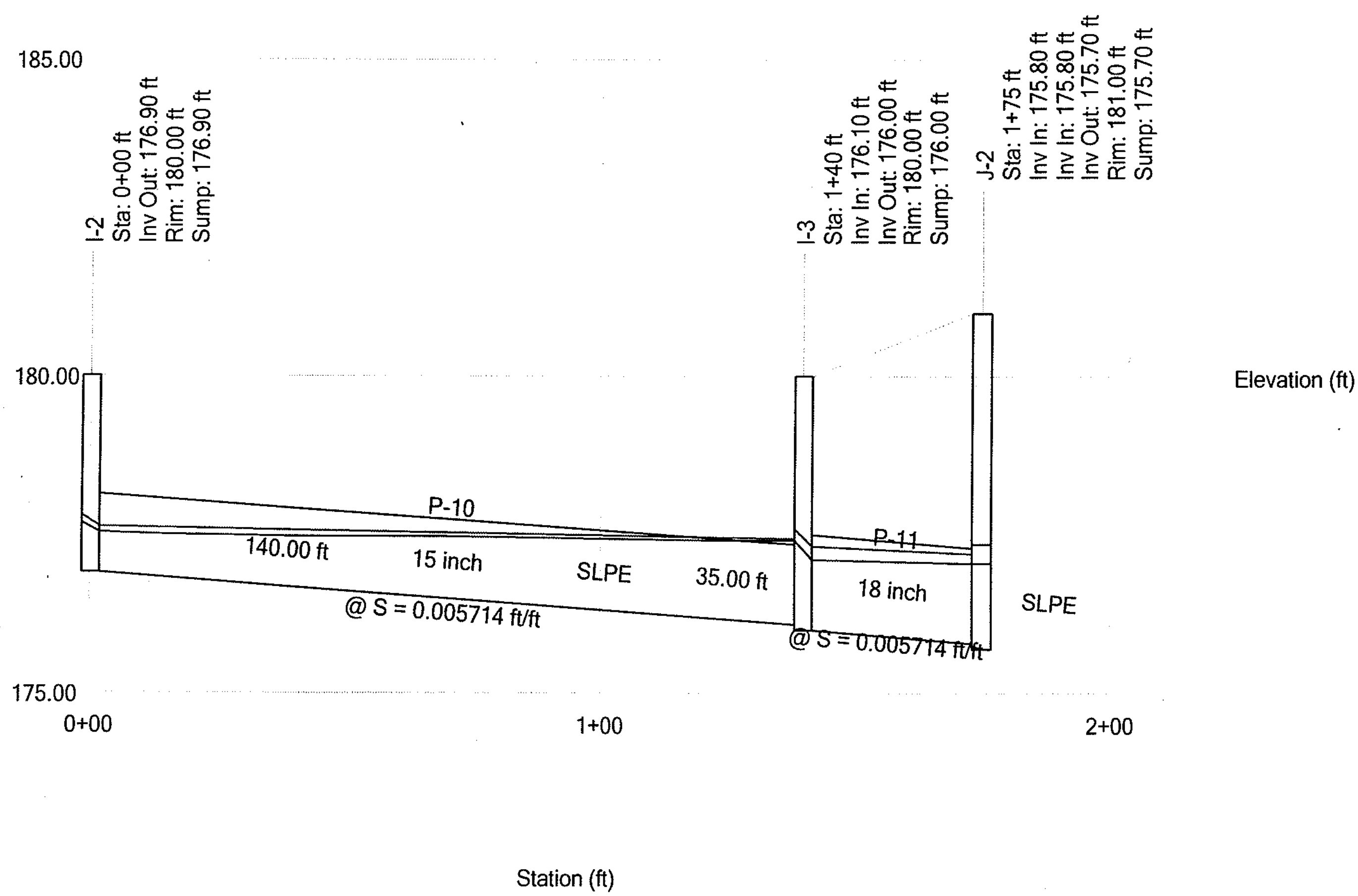
Profile
Scenario: Base

Profile: I-1 to J-1 to J-2
Scenario: Base



Profile: I-2 to I-3 to J-2

Scenario: Base



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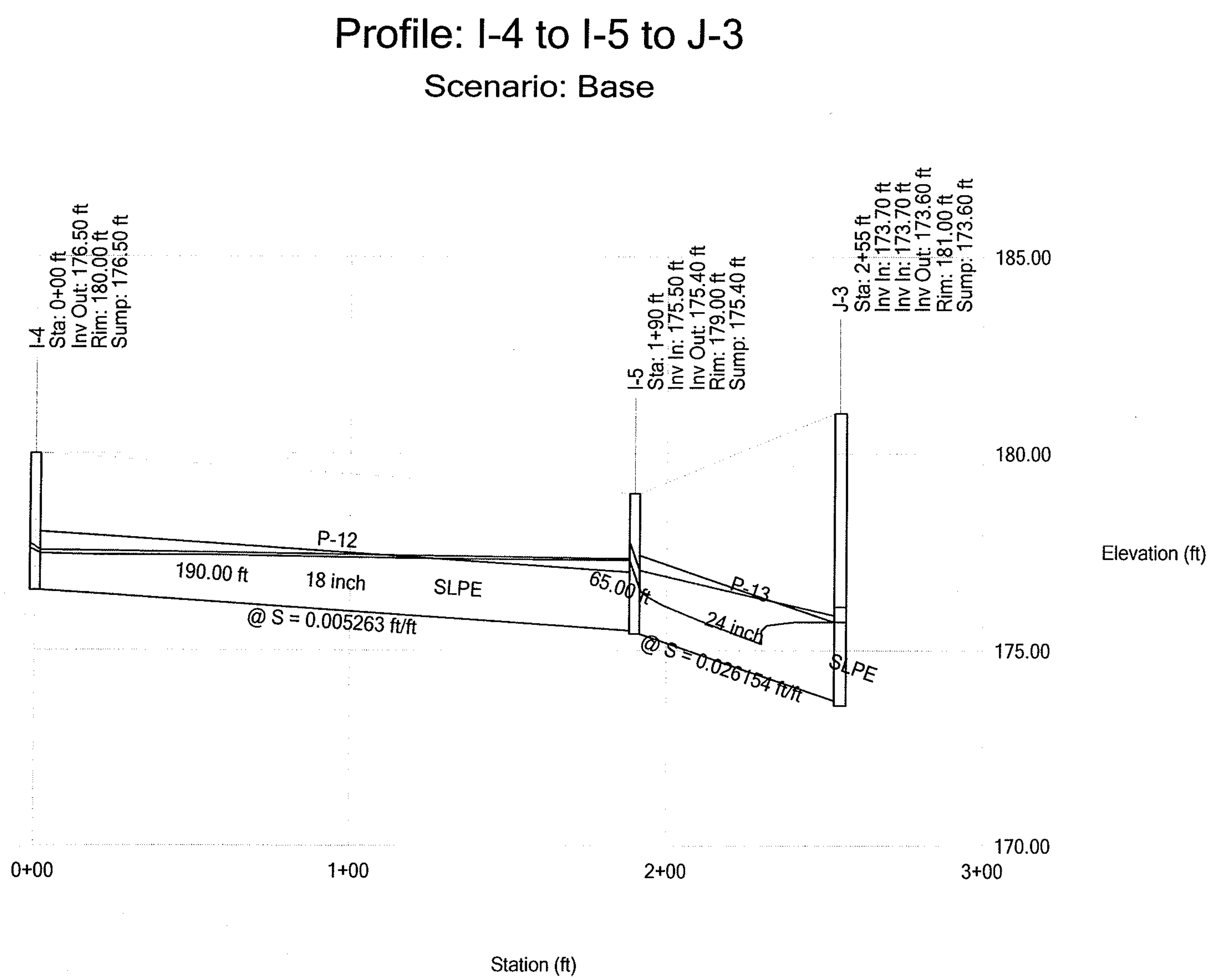
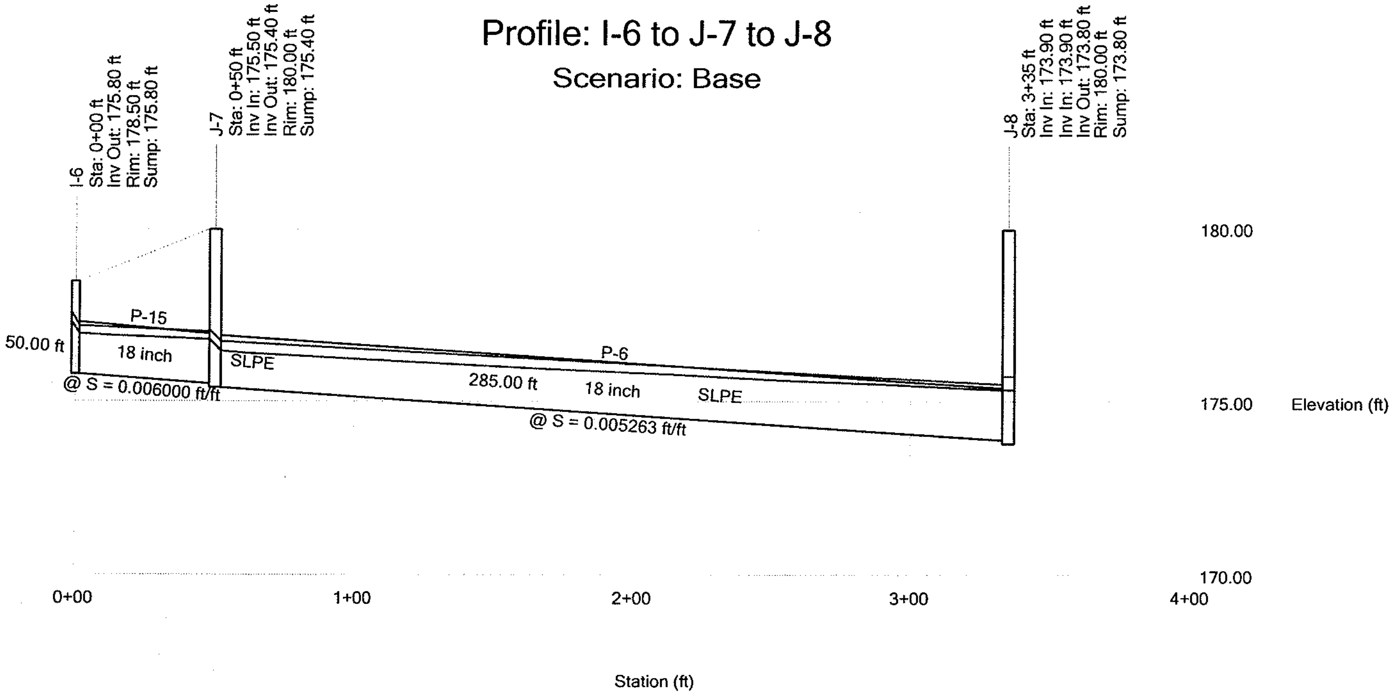
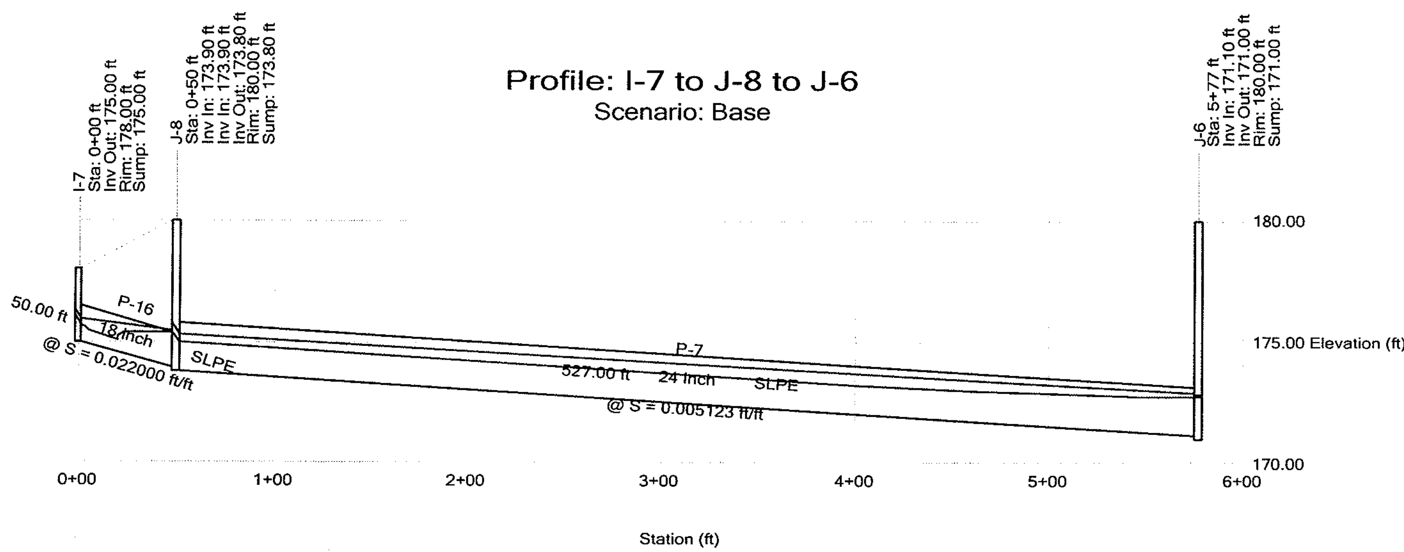


Profile
Scenario: Base



Profile
Scenario: Base



Profile
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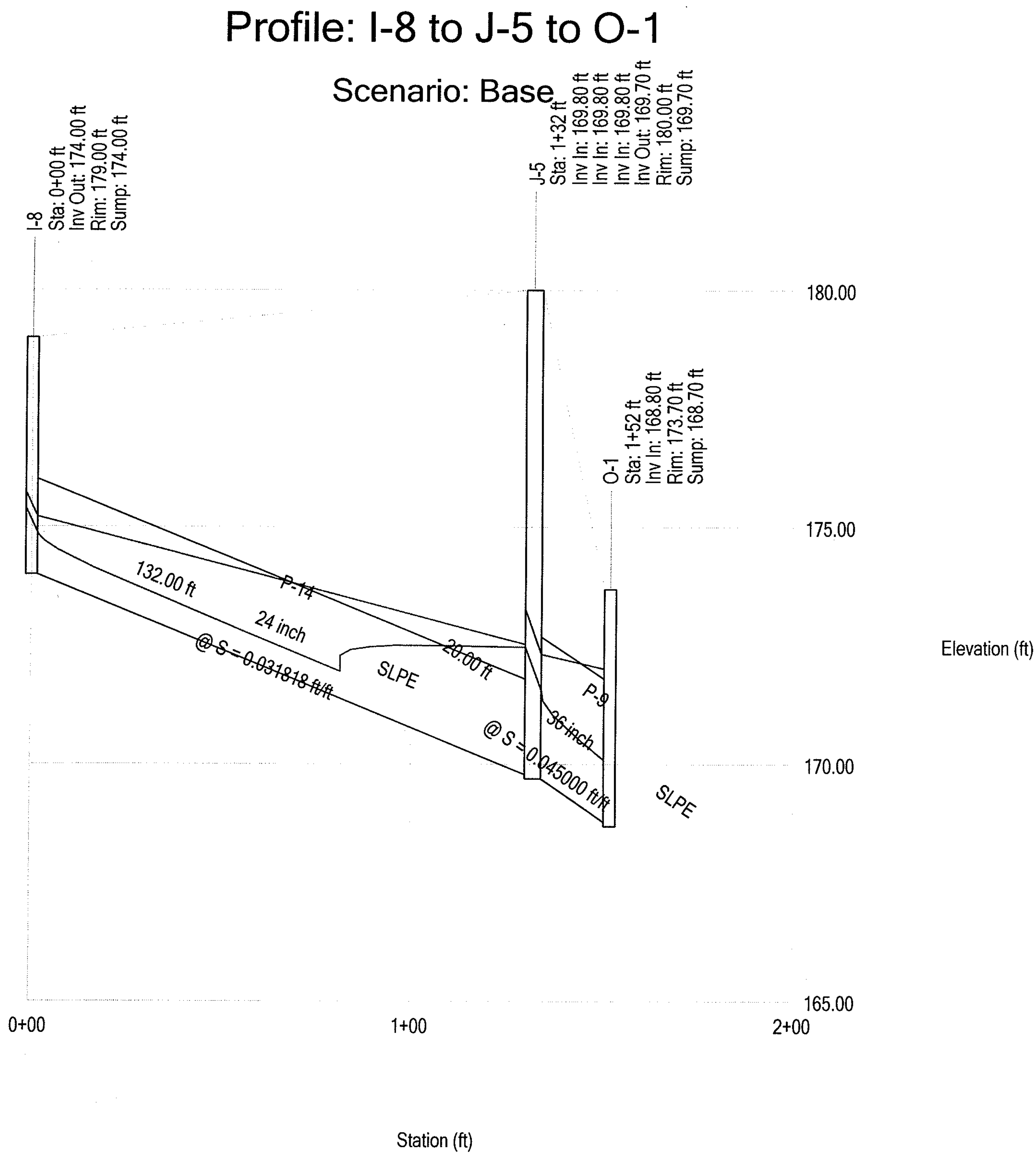
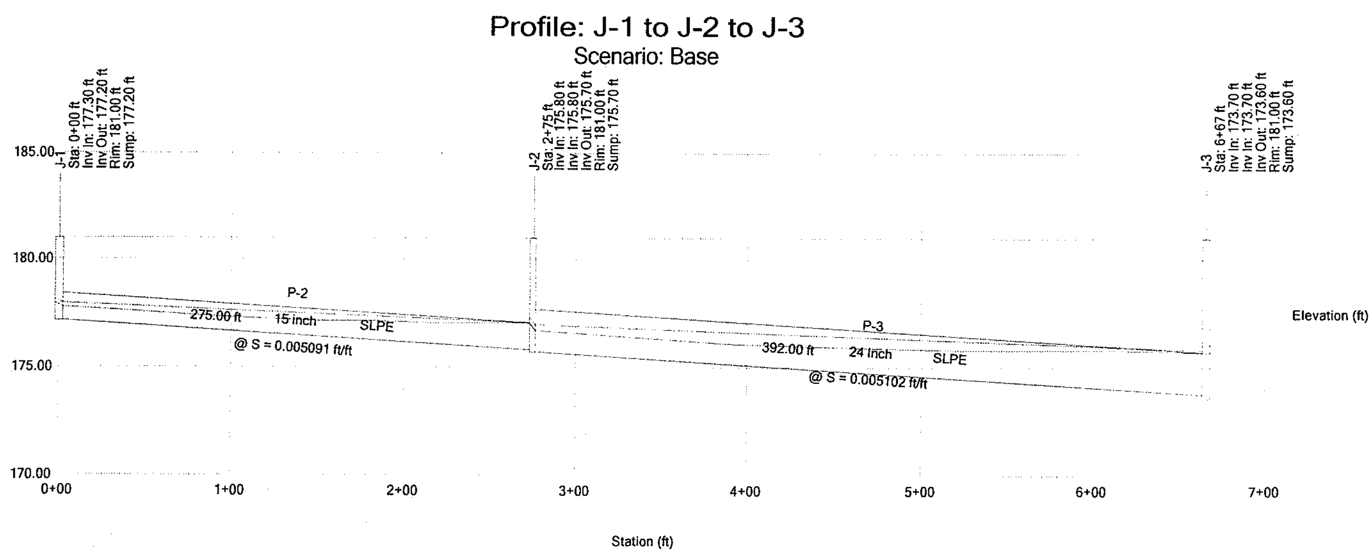


Profile
Scenario: Base



Profile
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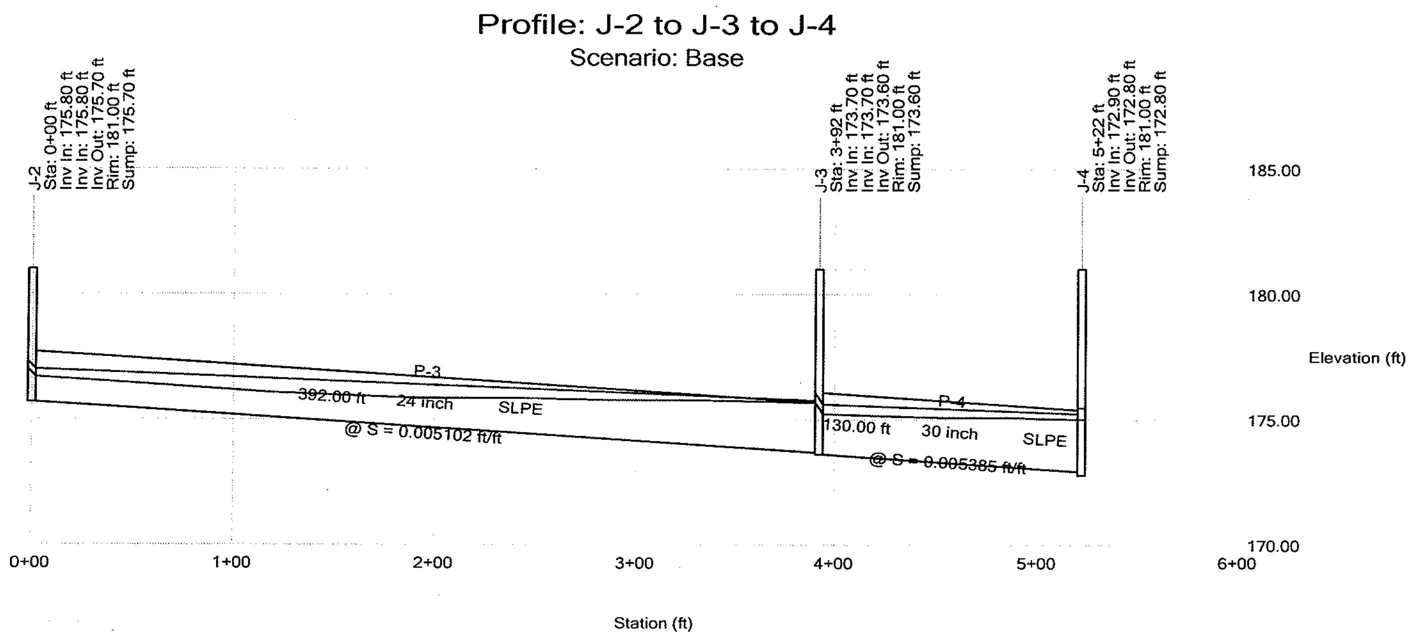
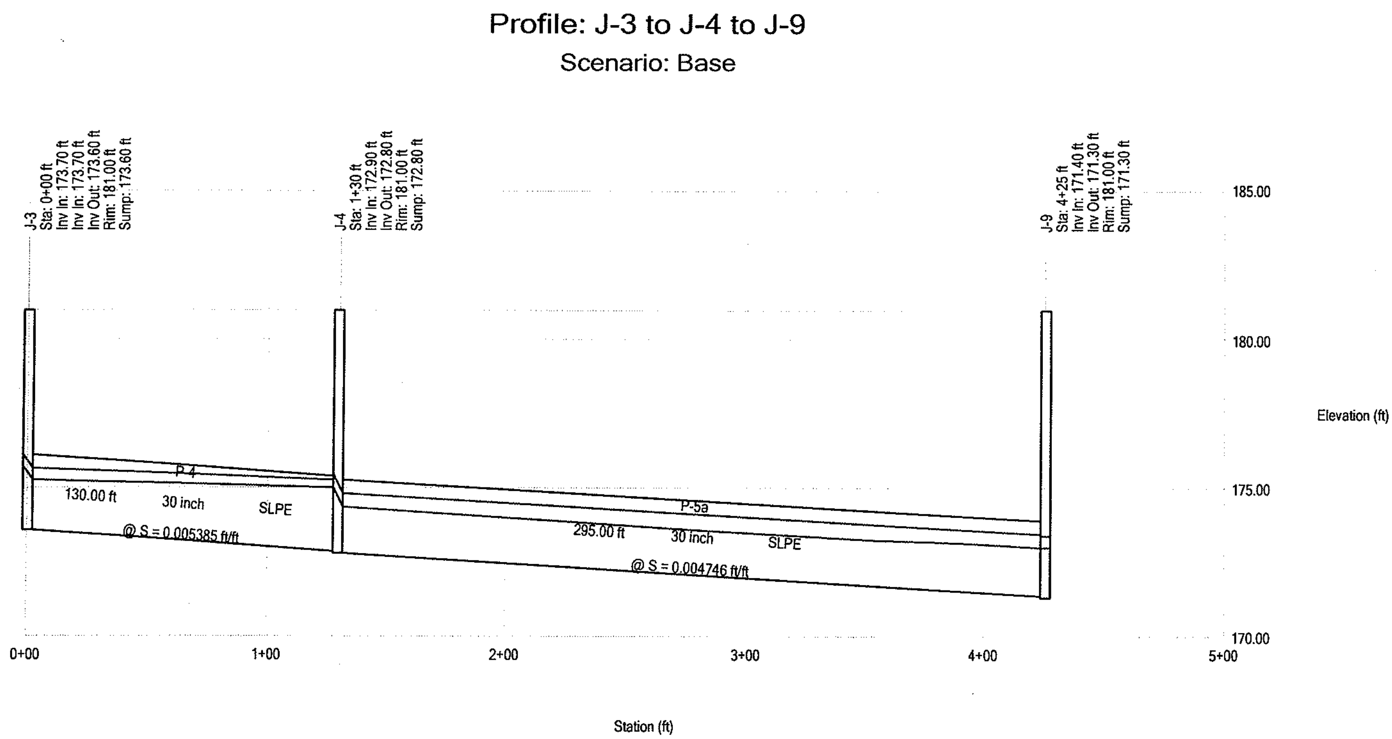


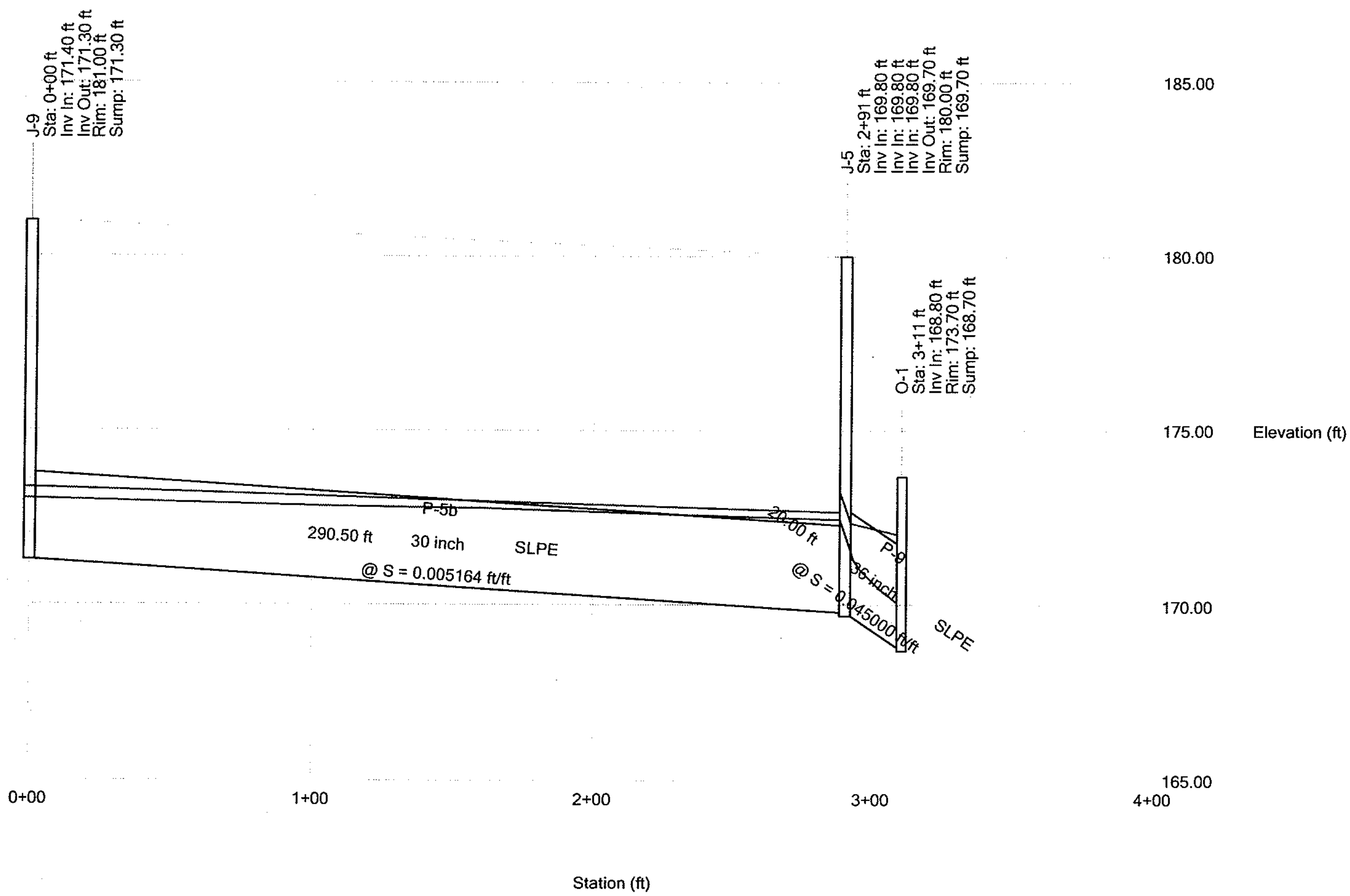
Profile
Scenario: Base



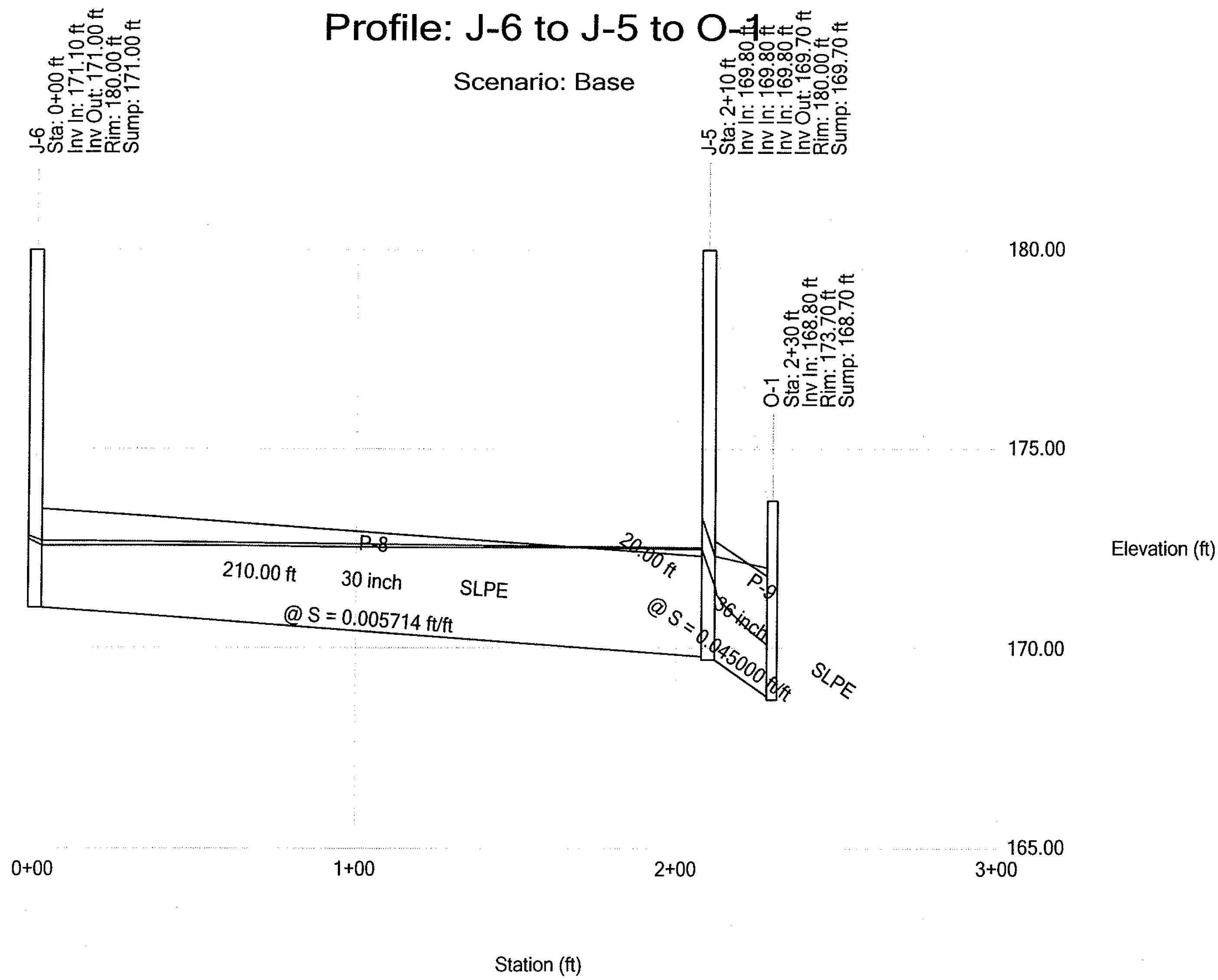
Profile
Scenario: Base

Profile: J-9 to J-5 to O-1

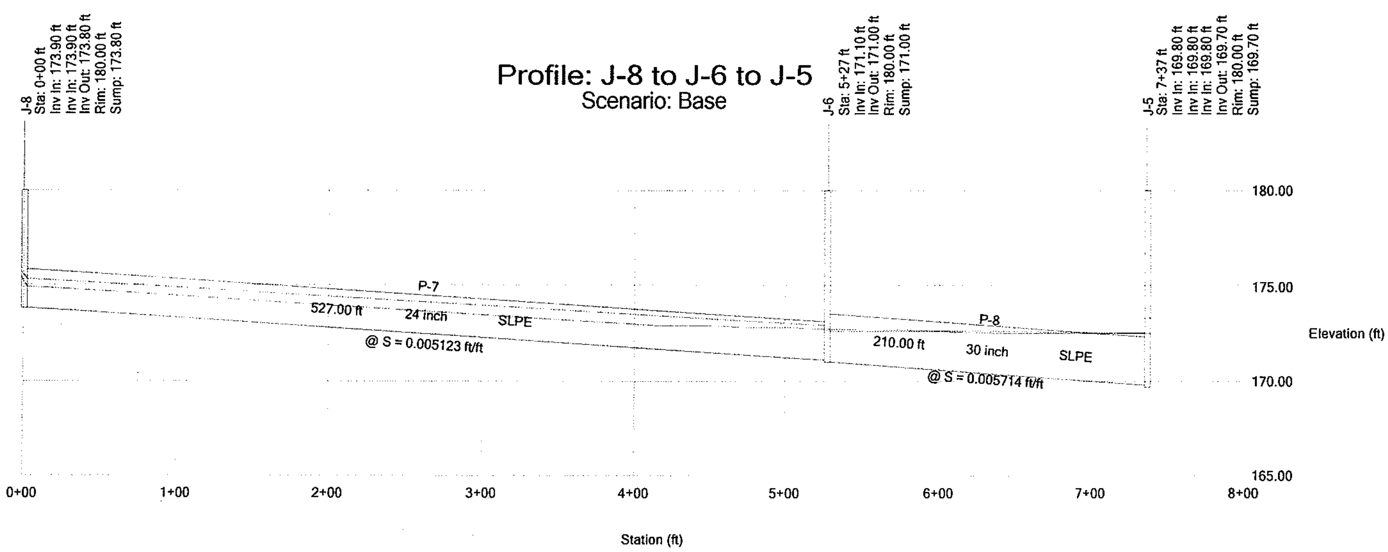
Scenario: Base



Profile
Scenario: Base



Profile
Scenario: Base



Calculation Results Summary

10-year Storm

Scenario: Base

>>>> Info: Subsurface Network Rooted by: O-1
>>>> Info: Subsurface Analysis iterations: 1
>>>> Info: Convergence was achieved.

CALCULATION SUMMARY FOR SURFACE NETWORKS

Label	Inlet Type	Inlet	Total Intercepted Flow (cfs)	Total Bypassed Flow (cfs)	Capture Efficiency (%)	Gutter Spread (ft)	Gutter Depth (ft)
I-8	Generic Inlet	Generic Default 100%	3.83	0.00	100.0	0.00	0.00
I-6	Generic Inlet	Generic Default 100%	3.65	0.00	100.0	0.00	0.00
I-7	Generic Inlet	Generic Default 100%	1.79	0.00	100.0	0.00	0.00
I-1	Generic Inlet	Generic Default 100%	0.98	0.00	100.0	0.00	0.00
I-3	Generic Inlet	Generic Default 100%	1.89	0.00	100.0	0.00	0.00
I-2	Generic Inlet	Generic Default 100%	0.92	0.00	100.0	0.00	0.00
I-5	Generic Inlet	Generic Default 100%	4.33	0.00	100.0	0.00	0.00
I-4	Generic Inlet	Generic Default 100%	1.70	0.00	100.0	0.00	0.00

CALCULATION SUMMARY FOR SUBSURFACE NETWORK WITH ROOT: O-1

Label	Number of Sections	Section Size	Section Shape	Length (ft)	Total System Flow (cfs)	Average Velocity (ft/s)	Hydraulic Grade Upstream (ft)	Hydraulic Grade Downstream (ft)
P-9	1	36 inch	Circular	20.00	19.09	12.61	171.10	169.74
P-14	1	24 inch	Circular	132.00	3.83	7.31	174.69	171.75
P-8	1	30 inch	Circular	210.00	5.44	4.29	171.79	171.75
P-5b	1	30 inch	Circular	290.50	9.82	4.86	172.38	171.75
P-7	1	24 inch	Circular	527.00	5.44	4.18	174.66	172.10
P-5a	1	30 inch	Circular	295.00	9.82	4.71	173.90	172.45
P-16	1	18 inch	Circular	50.00	1.79	5.30	175.50	174.99
P-6	1	18 inch	Circular	285.00	3.65	3.83	176.20	174.99
P-4	1	30 inch	Circular	130.00	9.82	4.94	174.66	174.42
P-15	1	18 inch	Circular	50.00	3.65	4.02	176.58	176.47
P-13	1	24 inch	Circular	65.00	6.03	7.77	176.27	175.12
P-3	1	24 inch	Circular	392.00	3.79	3.79	176.41	175.12
P-12	1	18 inch	Circular	190.00	1.70	3.13	177.02	176.76
P-2	1	15 inch	Circular	275.00	0.98	2.69	177.62	176.68
P-11	1	18 inch	Circular	35.00	2.81	3.70	176.72	176.68
P-1	1	12 inch	Circular	45.00	0.98	3.01	178.03	177.76
P-10	1	15 inch	Circular	140.00	0.92	2.76	177.30	176.98

Label	Total System Flow (cfs)	Ground Elevation (ft)	Hydraulic Grade Line In (ft)	Hydraulic Grade Line Out (ft)
O-1	19.09	173.70	168.70	168.70
J-5	19.09	180.00	171.75	171.10
I-8	3.83	179.00	175.06	174.69
J-6	5.44	180.00	172.10	171.79
J-9	9.82	181.00	172.38	172.38

Calculation Results Summary

J-8	5.44	180.00	174.99	174.66
J-4	9.82	181.00	174.42	173.90
I-7	1.79	178.00	175.78	175.50
J-7	3.65	180.00	176.47	176.20
J-3	9.82	181.00	175.12	174.66
I-6	3.65	178.50	176.94	176.58
I-5	6.03	179.00	176.76	176.27
J-2	3.79	181.00	176.68	176.41
I-4	1.70	180.00	177.25	177.02
J-1	0.98	181.00	177.76	177.62
I-3	2.81	180.00	176.98	176.72
I-1	0.98	180.00	178.24	178.03
I-2	0.92	180.00	177.47	177.30

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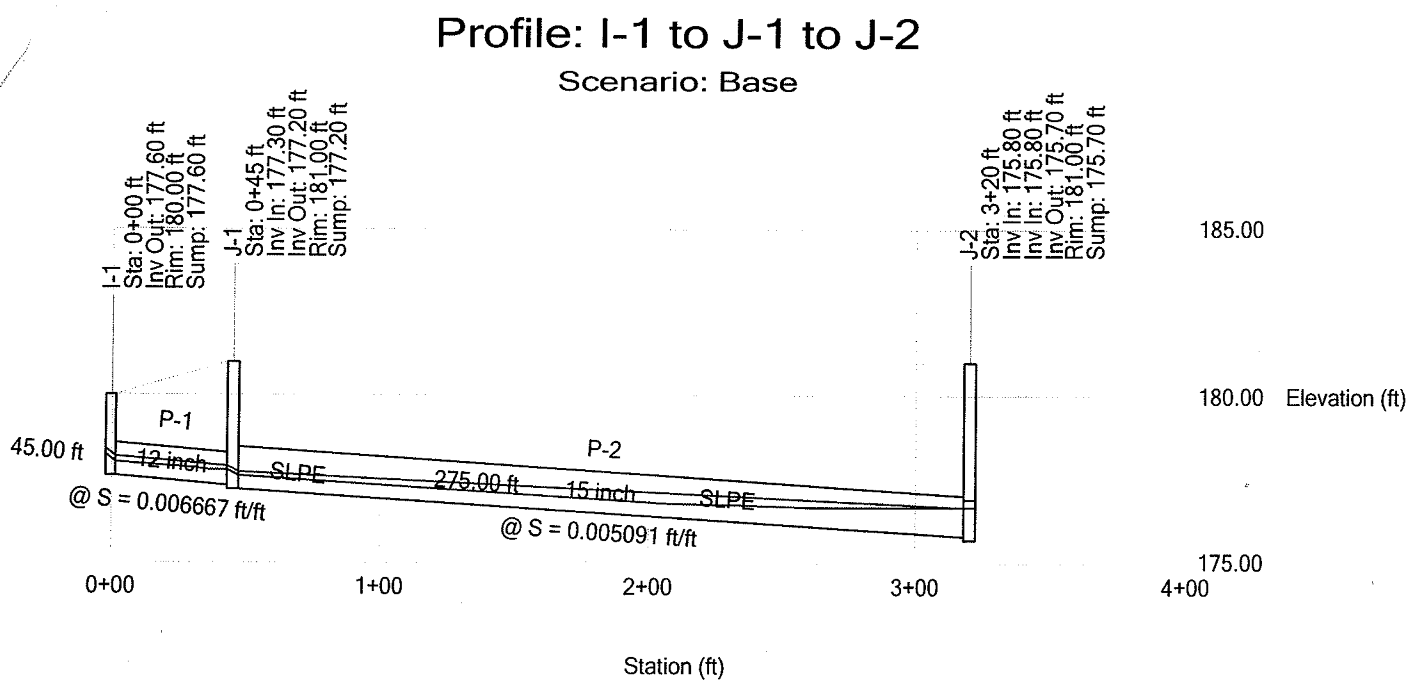
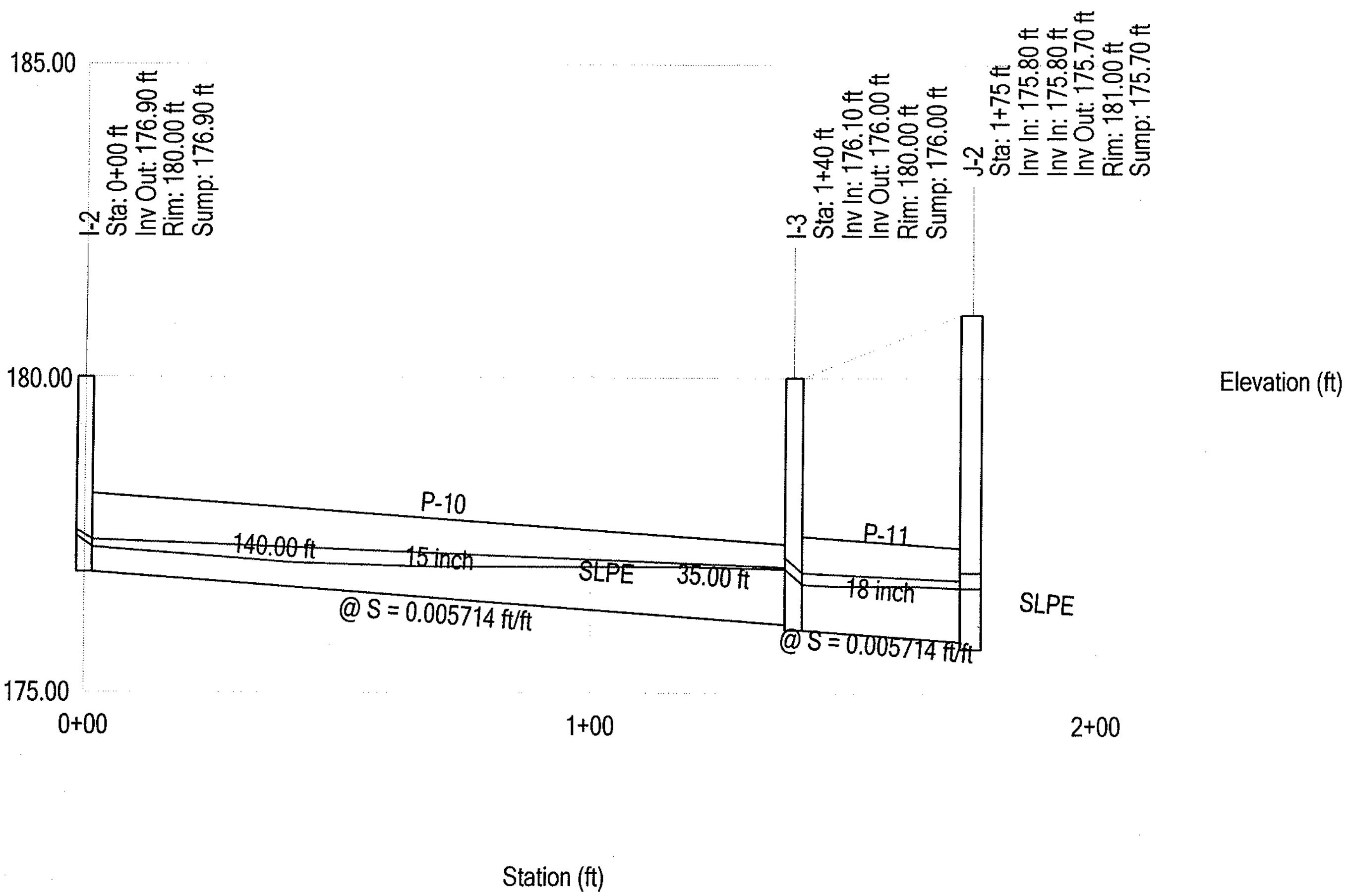
Profile
Scenario: Base

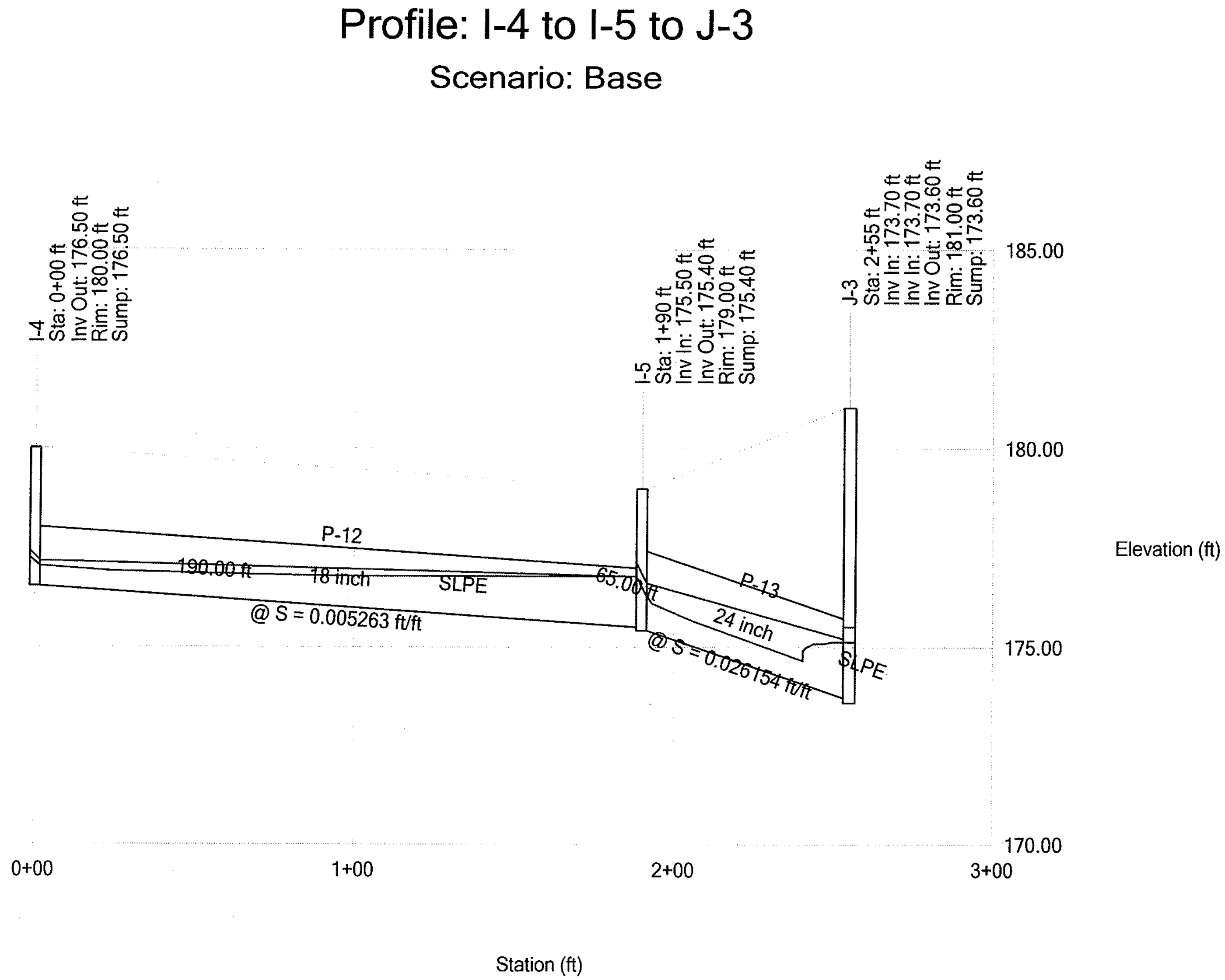


Profile: I-2 to I-3 to J-2

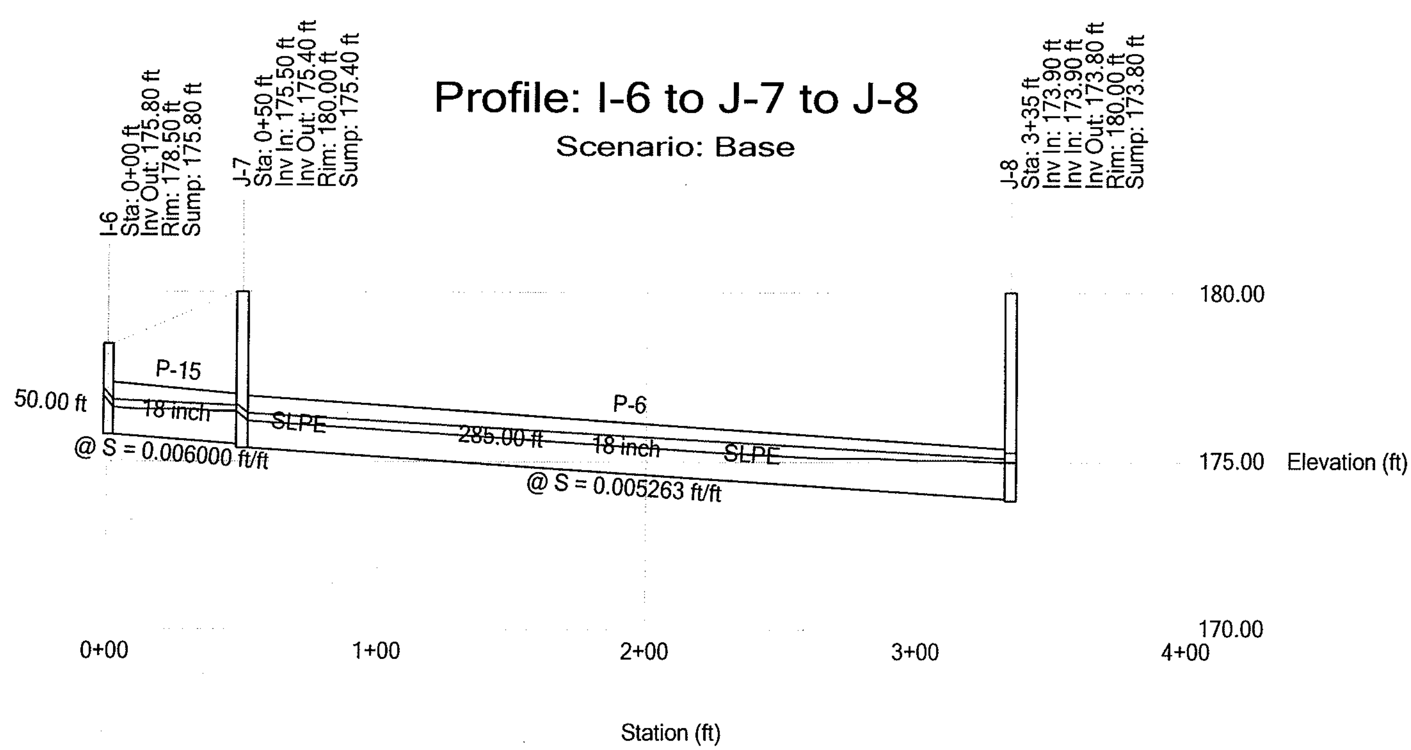
Scenario: Base



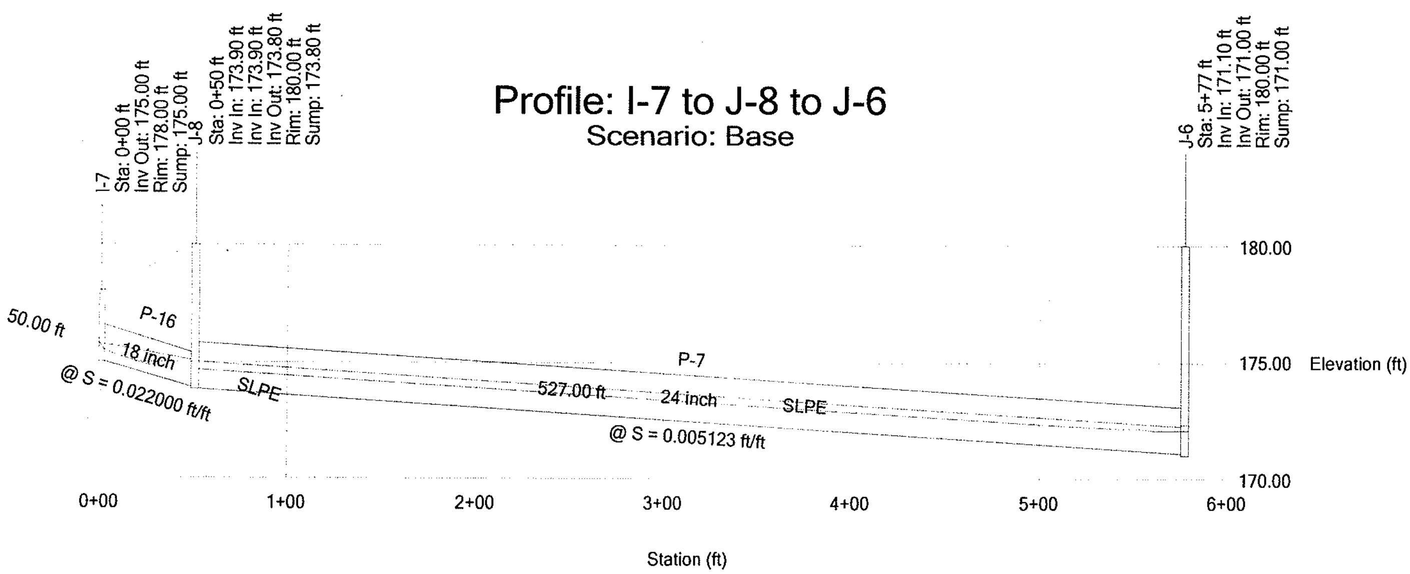
Profile
Scenario: Base



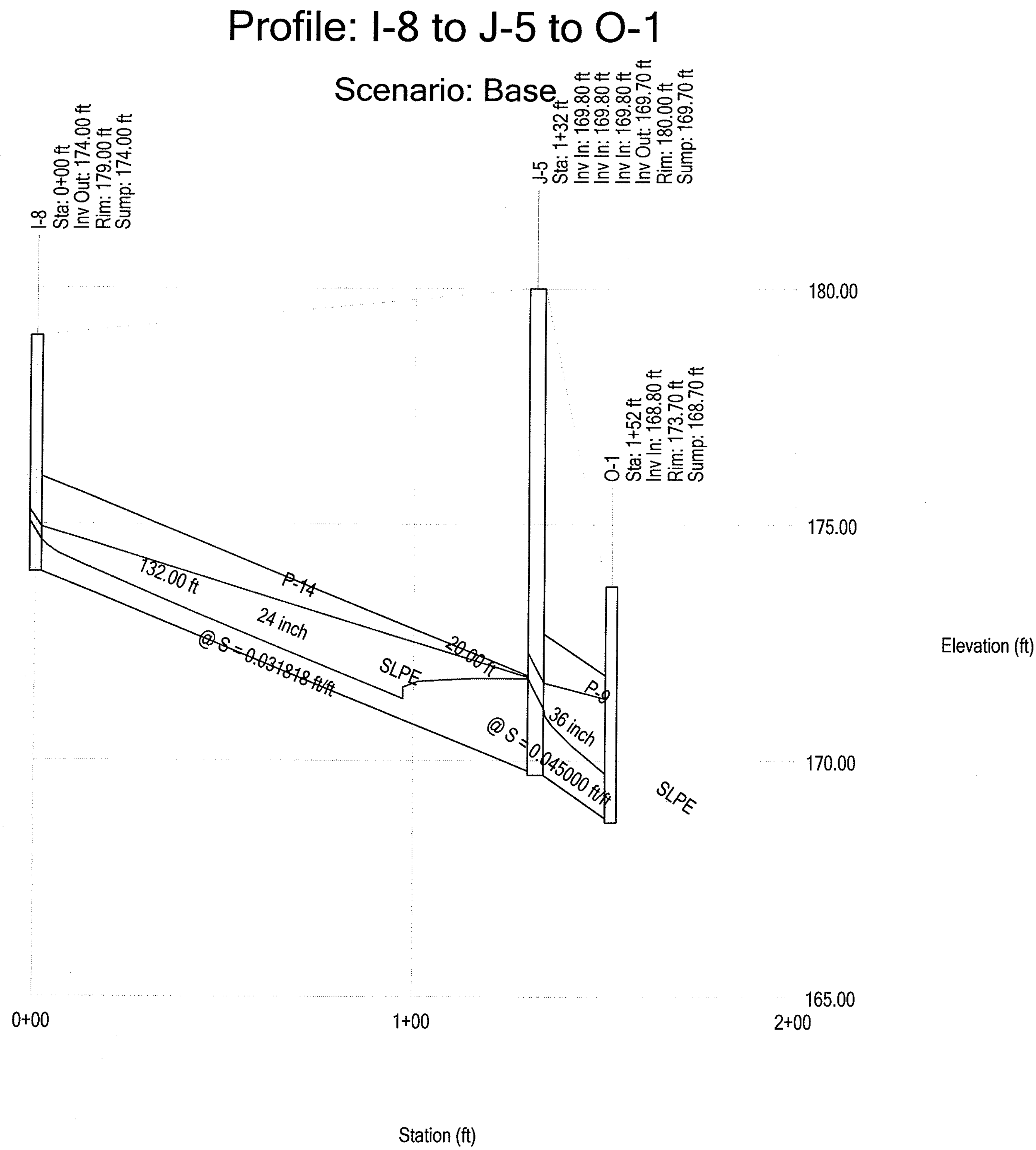
Profile
Scenario: Base



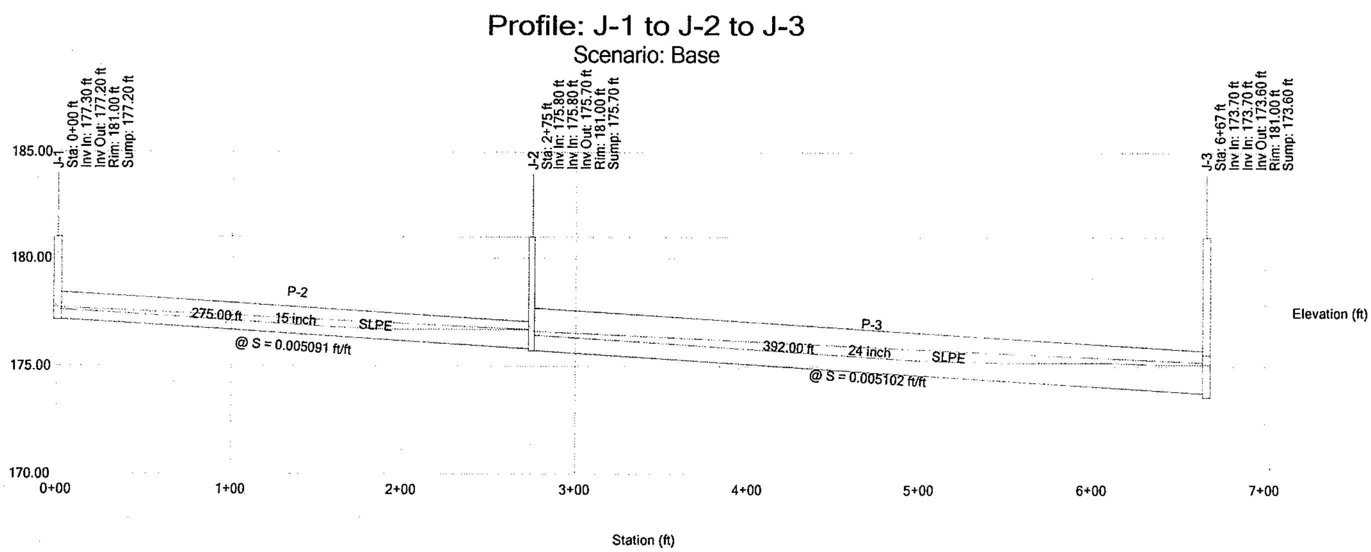
Profile
Scenario: Base



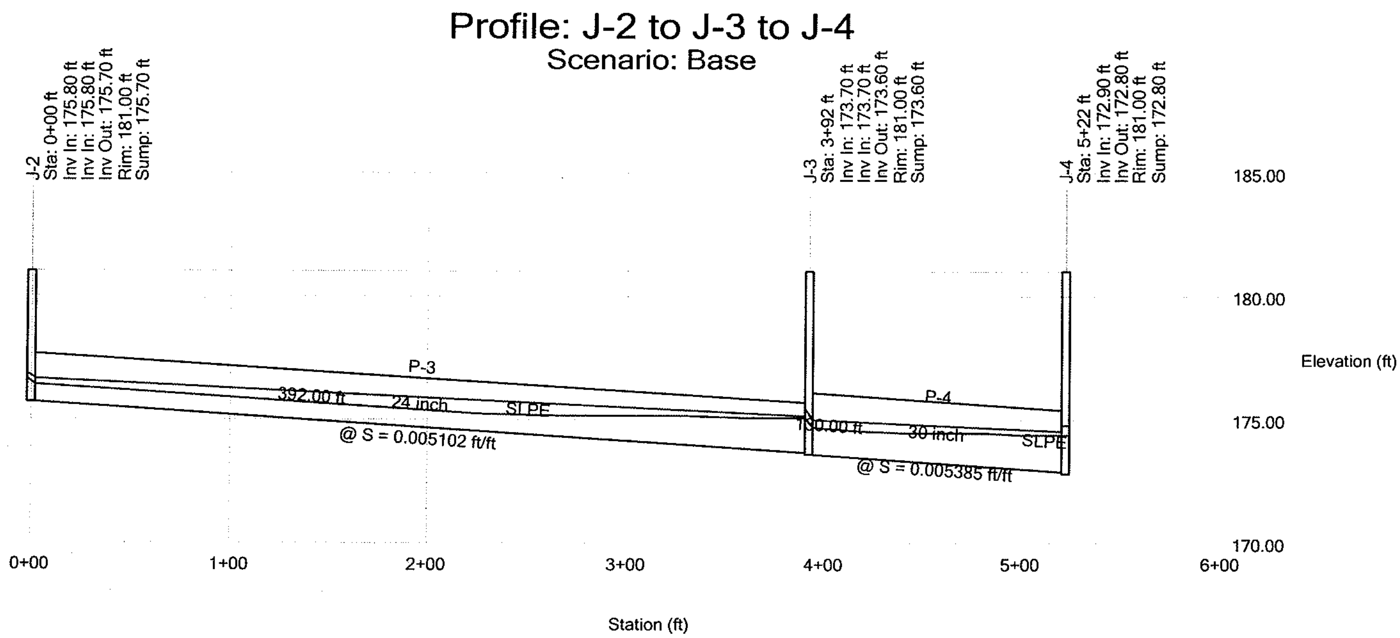
Profile
Scenario: Base



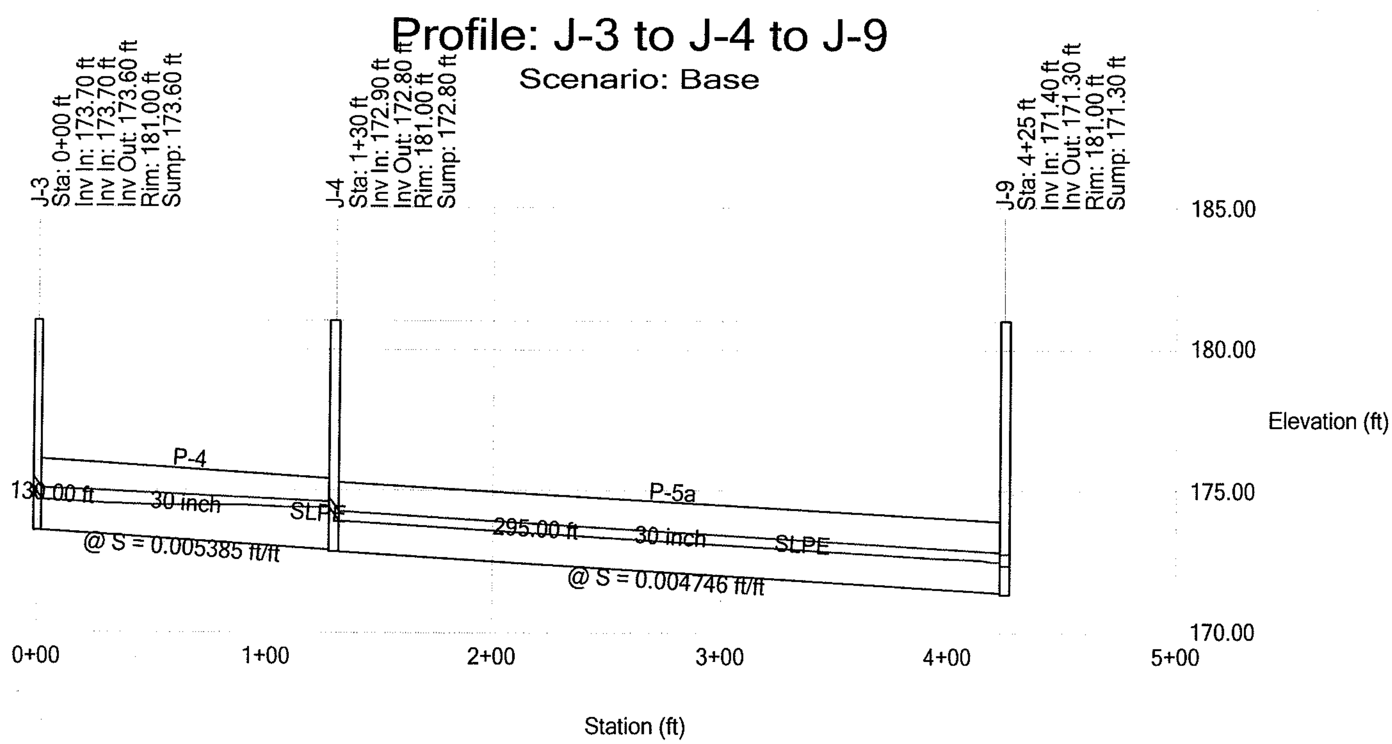
Profile
Scenario: Base



Profile
Scenario: Base



Profile
Scenario: Base



Profile
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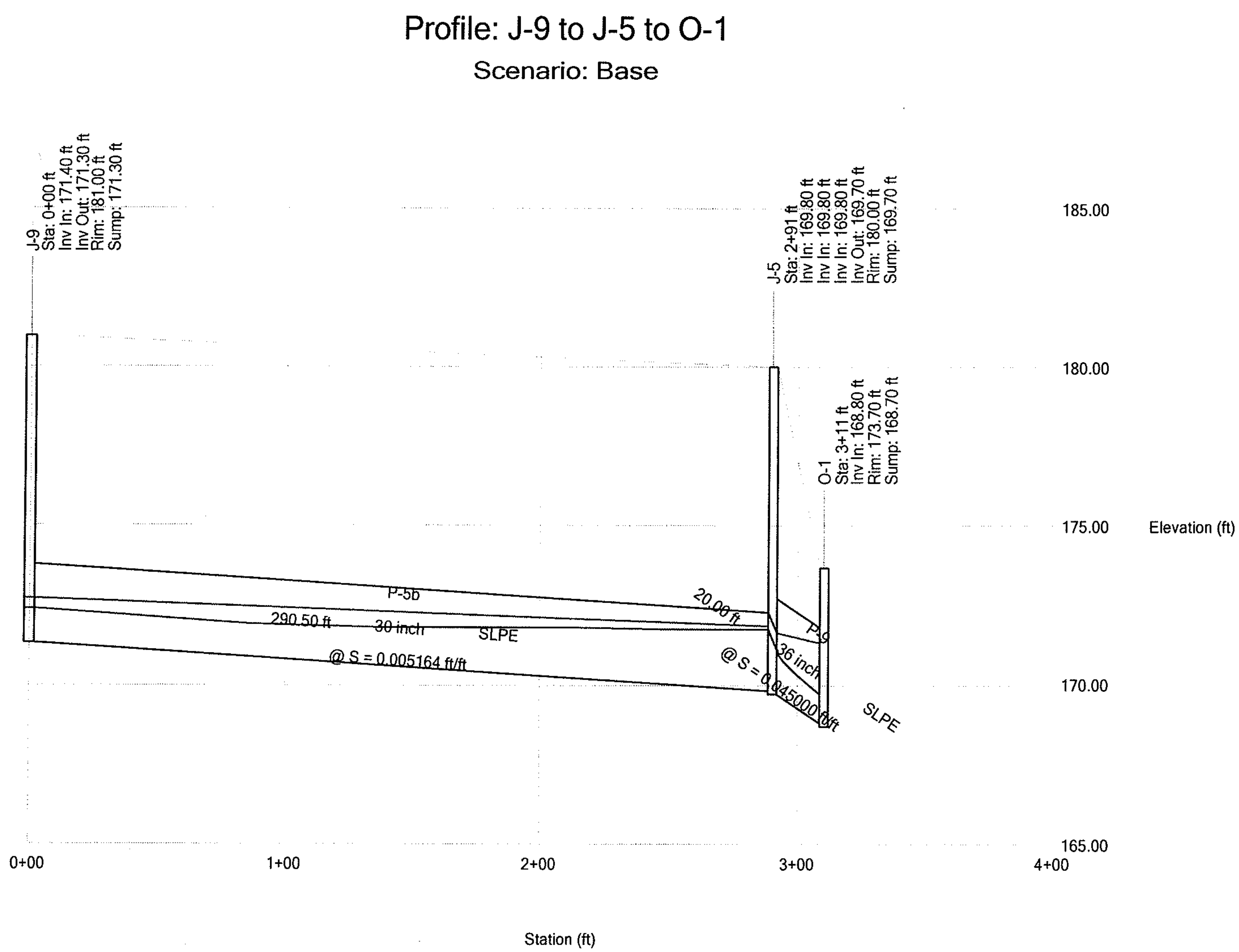
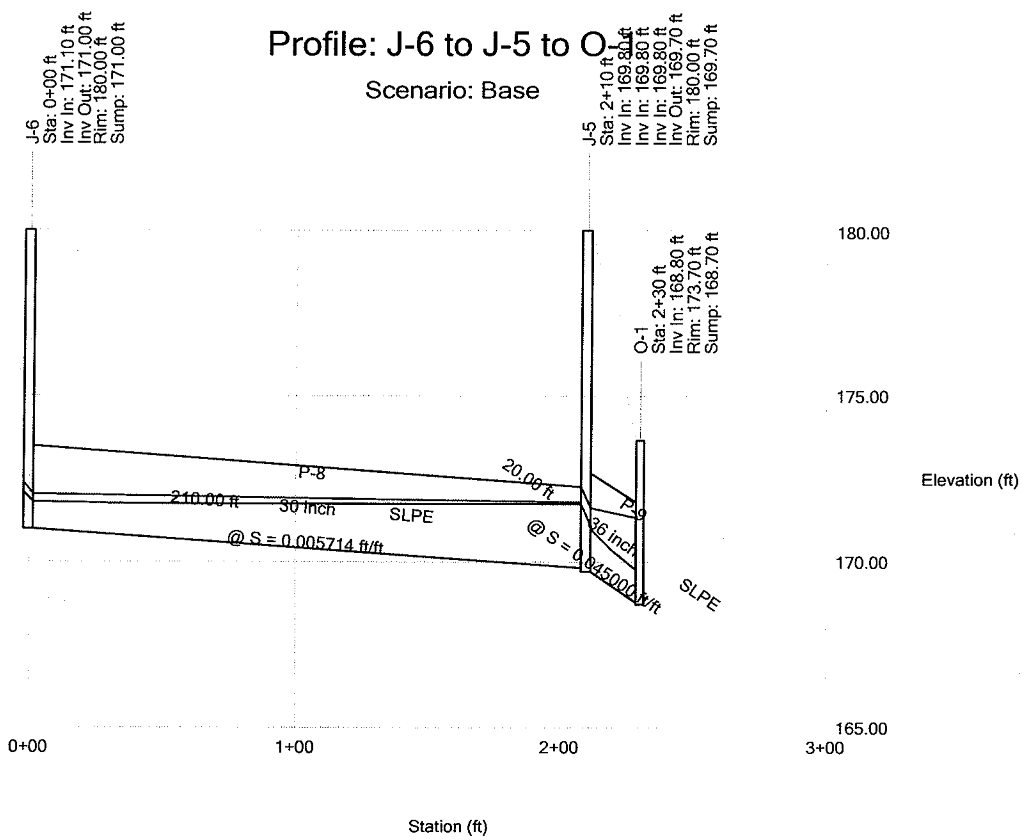
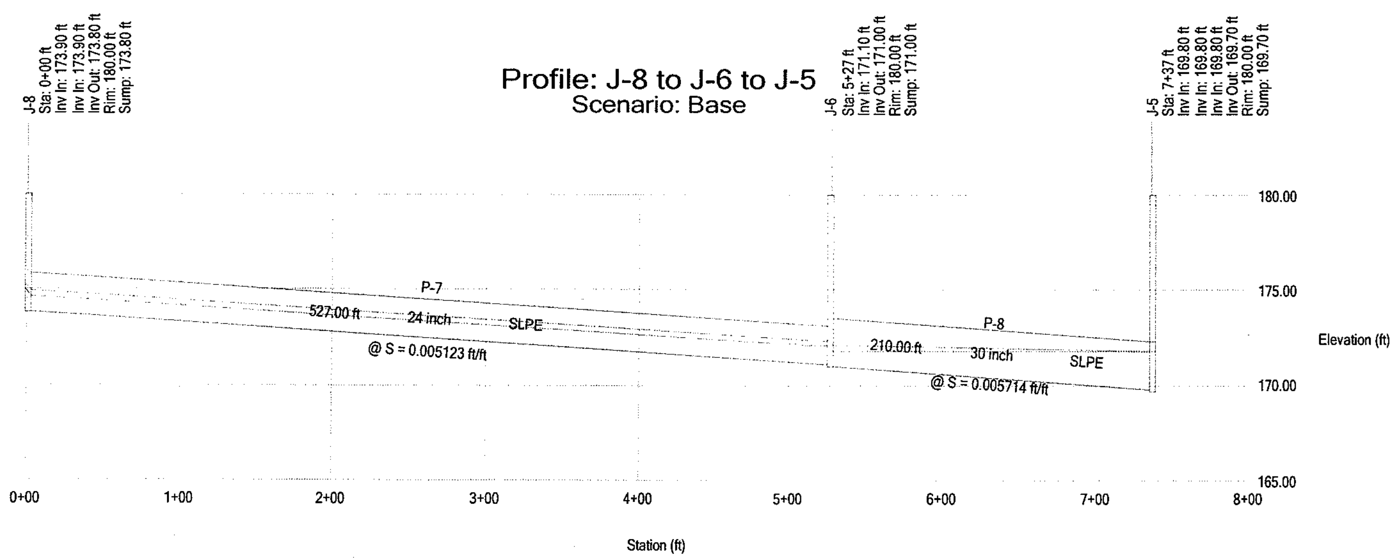


Profile
Scenario: Base



Profile
Scenario: Base



ATTACHMENT 14

COLUSA GENERATING STATION
COLS-1-DC-024-0001

SWALE CALCULATIONS

Worksheet for Swale Type A

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.00500	ft/ft
Normal Depth	1.00	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft

Results

Discharge	7.62	ft³/s
Flow Area	4.00	ft²
Wetted Perimeter	6.47	ft
Top Width	6.00	ft
Critical Depth	0.62	ft
Critical Slope	0.03315	ft/ft
Velocity	1.91	ft/s
Velocity Head	0.06	ft
Specific Energy	1.06	ft
Froude Number	0.41	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.00	ft
Critical Depth	0.62	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.03315	ft/ft

Worksheet for Swale Type B

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.040	
Channel Slope	0.00500	ft/ft
Normal Depth	2.00	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	2.00	ft

Results

Discharge	33.52	ft^3/s
Flow Area	12.00	ft^2
Wetted Perimeter	10.94	ft
Top Width	10.00	ft
Critical Depth	1.35	ft
Critical Slope	0.02738	ft/ft
Velocity	2.79	ft/s
Velocity Head	0.12	ft
Specific Energy	2.12	ft
Froude Number	0.45	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.00	ft
Critical Depth	1.35	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.02738	ft/ft

ATTACHMENT 15

COLUSA GENERATING STATION
COLS-1-DC-024-0001

WEIR CALCULATIONS

Worksheet for Broad Crested Weir - North Basin - 10-year

Project Description

Solve For	Crest Elevation

Input Data

Discharge		22.62	ft³/s
Headwater Elevation		0.90	ft
Tailwater Elevation		0.00	ft
Crest Surface Type	Gravel		
Crest Breadth		10.00	ft
Crest Length		20.00	ft

Results

Crest Elevation	0.34	ft	
Headwater Height Above Crest	0.56	ft	
Tailwater Height Above Crest	-0.34	ft	
Weir Coefficient	2.71	US	
Submergence Factor	1.00		
Adjusted Weir Coefficient	2.71	US	
Flow Area	11.17	ft²	
Velocity	2.03	ft/s	< 3.5 ft/s ∴ OK
Wetted Perimeter	21.12	ft	
Top Width	20.00	ft	

Worksheet for Velocity Check - North Basin Spillway - 10-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.078	
Channel Slope	0.16850	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	20.00	ft
Discharge	22.62	ft^3/s

Results

Normal Depth	0.31	ft	
Flow Area	6.51	ft^2	
Wetted Perimeter	21.97	ft	
Top Width	21.87	ft	
Critical Depth	0.34	ft	
Critical Slope	0.13045	ft/ft	
Velocity	3.47	ft/s	< 3.5 ft/s ∴ OK
Velocity Head	0.19	ft	
Specific Energy	0.50	ft	
Froude Number	1.12		
Flow Type	Supercritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.31	ft
Critical Depth	0.34	ft
Channel Slope	0.16850	ft/ft
Critical Slope	0.13045	ft/ft

Worksheet for Broad Crested Weir - South Basin - 10-year

Project Description

Solve For	Crest Elevation

Input Data

Discharge		6.96	ft^3/s
Headwater Elevation		1.00	ft
Tailwater Elevation		0.00	ft
Crest Surface Type	Gravel		
Crest Breadth		10.00	ft
Crest Length		20.00	ft

Results

Crest Elevation	0.74	ft	
Headwater Height Above Crest	0.26	ft	
Tailwater Height Above Crest	-0.74	ft	
Weir Coefficient	2.61	US	
Submergence Factor	1.00		
Adjusted Weir Coefficient	2.61	US	
Flow Area	5.22	ft^2	
Velocity	1.33	ft/s	$<$ 3.5 ft/s $\therefore$ OK
Wetted Perimeter	20.52	ft	
Top Width	20.00	ft	

Worksheet for Velocity Check - South Basin Spillway - 10-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.078	
Channel Slope	0.00330	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	20.00	ft
Discharge	6.96	ft^3/s

Results

Normal Depth	0.50	ft
Flow Area	10.66	ft^2
Wetted Perimeter	23.14	ft
Top Width	22.98	ft
Critical Depth	0.15	ft
Critical Slope	0.16706	ft/ft
Velocity	0.65	ft/s < 3.5 ft/s ∴ OK
Velocity Head	0.01	ft
Specific Energy	0.50	ft
Froude Number	0.17	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.50	ft
Critical Depth	0.15	ft
Channel Slope	0.00330	ft/ft
Critical Slope	0.16706	ft/ft

Worksheet for Broad Crested Weir - West Basin (Sediment) - 100-year

Project Description

Solve For	Crest Elevation

Input Data

Discharge		32.47	ft³/s
Headwater Elevation		1.00	ft
Tailwater Elevation		0.00	ft
Crest Surface Type	Gravel		
Crest Breadth		10.00	ft
Crest Length		40.00	ft

Results

Crest Elevation	0.55	ft	
Headwater Height Above Crest	0.45	ft	
Tailwater Height Above Crest	-0.55	ft	
Weir Coefficient	2.68	US	
Submergence Factor	1.00		
Adjusted Weir Coefficient	2.68	US	
Flow Area	18.05	ft²	
Velocity	1.80	ft/s	< 3.5 ft/s ∴ OK
Wetted Perimeter	40.90	ft	
Top Width	40.00	ft	

Worksheet for Velocity Check - West Basin Spillway - 100-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.078	
Channel Slope	0.01590	ft/ft
Left Side Slope	3.00	ft/ft (H:V)
Right Side Slope	3.00	ft/ft (H:V)
Bottom Width	20.00	ft
Discharge	32.47	ft³/s

Results

Normal Depth	0.77	ft
Flow Area	17.26	ft²
Wetted Perimeter	24.89	ft
Top Width	24.64	ft
Critical Depth	0.42	ft
Critical Slope	0.12121	ft/ft
Velocity	1.88	ft/s < 3.5 ft/s ∴ OK
Velocity Head	0.05	ft
Specific Energy	0.83	ft
Froude Number	0.40	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

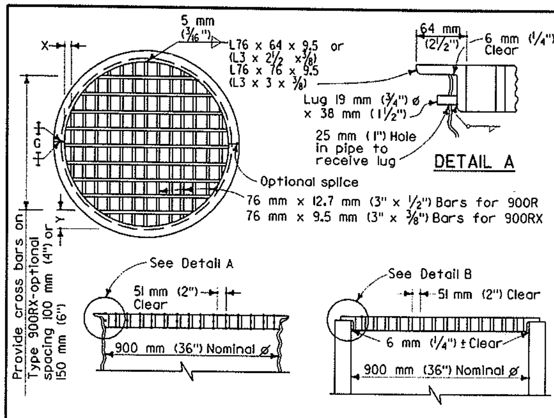
GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.77	ft
Critical Depth	0.42	ft
Channel Slope	0.01590	ft/ft
Critical Slope	0.12121	ft/ft

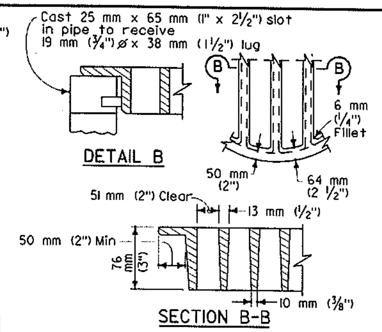
ATTACHMENT 16

COLUSA GENERATING STATION
COLS-1-DC-024-0001

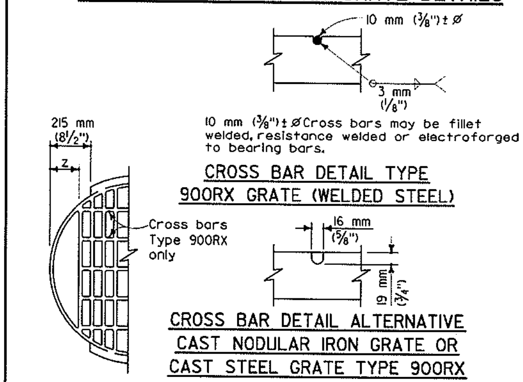
STANDARD 600-10C GRATE



TYPE 900R AND 900RX GRATE DETAILS



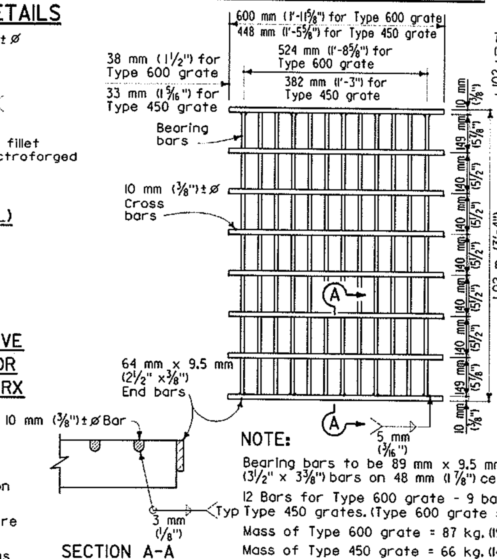
ALTERNATIVE CAST NODULAR IRON GRATE OR CAST STEEL GRATE TYPE 900R AND 900RX



CROSS BAR DETAIL TYPE 900RX GRATE (WELDED STEEL)

CROSS BAR DETAIL ALTERNATIVE CAST NODULAR IRON GRATE OR CAST STEEL GRATE TYPE 900RX

MODIFIED TYPE 900R AND 900RX GRATE FOR ODI INLET



NOTE:

Bearing bars to be 89 mm x 9.5 mm (3 1/2" x 3/8") bars on 48 mm (1 7/8") centers.

12 Bars for Type 600 grate - 9 bars for Type 450 grates. (Type 600 grate shown.)

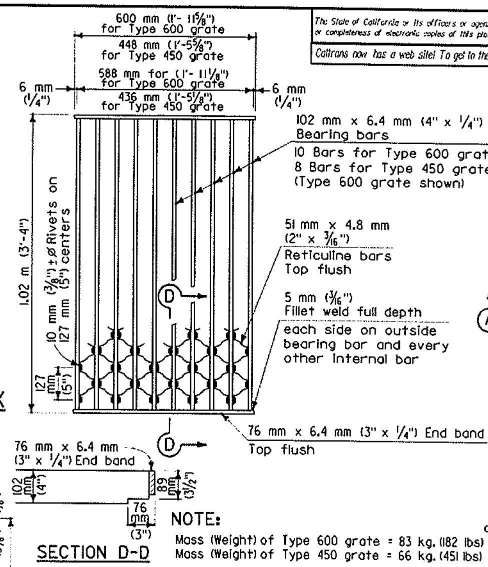
Mass of Type 600 grate = 87 kg. (192 lbs)

Mass of Type 450 grate = 66 kg. (145 lbs)

10 mm (3/8") ± ø Cross bars may be fillet welded, resistance welded or electroforged to bearing bars.

TYPE 450-9X AND 600-12X GRATE

(Welded Steel)



NOTE:

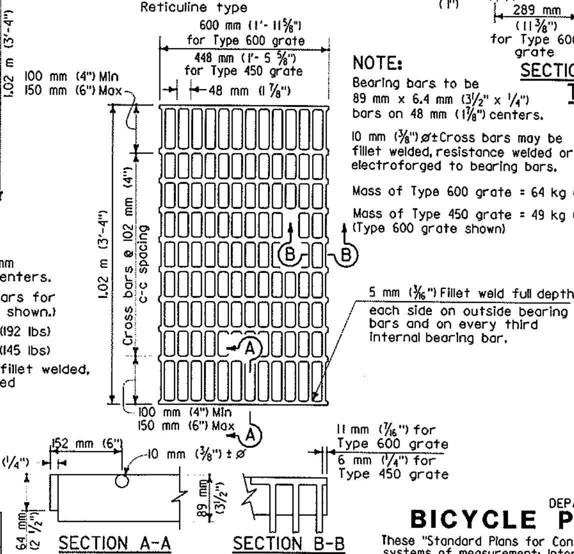
Mass (Weight) of Type 600 grate = 83 kg. (182 lbs)

Mass (Weight) of Type 450 grate = 66 kg. (145 lbs)

TYPE 450-8S AND 600-10S GRATE

(Welded Steel)

Reticuline type



NOTE:

Bearing bars to be 89 mm x 6.4 mm (3 1/2" x 1/4") bars on 48 mm (1 7/8") centers.

10 mm (3/8") ø ± Cross bars may be fillet welded, resistance welded or electroforged to bearing bars.

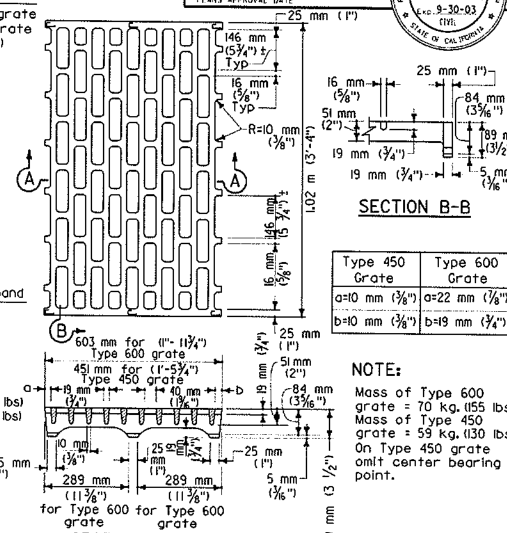
Mass of Type 600 grate = 64 kg (141 lbs).

Mass of Type 450 grate = 49 kg (107 lbs). (Type 600 grate shown)

5 mm (3/16") Fillet weld full depth each side on outside bearing bars and on every third internal bearing bar.

TYPE 450-10 AND 600-13 GRATE

(Welded Steel)



Type 450 Grate	Type 600 Grate
a=10 mm (3/8")	a=22 mm (7/8")
b=10 mm (3/8")	b=19 mm (3/4")

NOTE:

Mass of Type 600 grate = 70 kg. (155 lbs)
Mass of Type 450 grate = 59 kg. (130 lbs)
On Type 450 grate omit center bearing point.

TYPE 450-8C AND 600-10C GRATE

(Cast nodular iron)

NOTES:

1. When alternative grates are allowed - Final pay based on alternative with the lesser mass.
2. Seal welding at all surfaces not required when grates are galvanized.
3. Use frame shown on Standard Plan D74A, D74B or D77A as appropriate.
4. When type 600-10S, 600-12X or 600-13 grates are used with GDO inlets, a 6.4 mm x 89 mm x 1.04 m (1/4" x 3 1/2" x 3'-4 7/8") steel bar shall be welded across the center of inlet frame to separate the individual grates.

GRATE BAR SPACING TABLE

TYPE	NO. OF BARS	CLEAR BAR SPACING	X (mm)	Y (mm) 100 (4") mm SPACING	Y (mm) 150 (6") mm SPACING	Z mm (in)
900R	13	51 mm (2")	54 (2 1/8")	-	-	-
900RX (Steel)	15	51 mm (2")	14 (9/16")	95 (3 3/4")	146 (5 3/4")	-
900RX (Cast)	13	51 mm (2")	54 (2 1/8")	95 (3 3/4")	146 (5 3/4")	-
900R Mod	12	51 mm (2")	54 (2 1/8")	-	-	127 (5")
900RX Mod (Steel)	13	51 mm (2")	14 (9/16")	95 (3 3/4")	146 (5 3/4")	144 (5 11/16")
900RX Mod (Cast)	12	51 mm (2")	54 (2 1/8")	95 (3 3/4")	146 (5 3/4")	127 (5")

INLET TYPE	GRATE TYPE	NO. OF GRATES	MASS (WEIGHT) kg (LB)
ODI	900RX (Mod)	1	89 (196)
GMP, GCP, GCPI	900RX	1	98 (215)
ODI	900R (Mod)	1	100 (220)
GMP, GCP, GCPI	900R	1	107 (236)

BASIS FOR MISC IRON & STEEL FINAL PAY MASSES (WEIGHTS) FOR DRAINAGE INLETS

INLET TYPE	GRATE TYPE	NO. GRATES	MASS (WEIGHT) kg (LB)
GDO (SEE NOTE 4)	600-10C	2	177 (391)
	600-10S	2	207 (456)
	600-12X	2	215 (473)
	600-13	2	170 (374)
GO,GOL,GI,G2, G3,G4 (TYPE 600)	600-10C	1	92 (202)
	600-10S	1	104 (229)
	600-12X	1	108 (239)
	600-13	1	85 (188)
G4 (TYPE 450) G5,G6	450-8S	1	85 (187)
	450-9X	1	85 (187)
	450-10	1	68 (149)
GT1,GT2	450-8S	2	170 (374)
	450-9X	2	170 (374)
	450-10	2	135 (298)
GT3,GT4	600-10C	2	183 (404)
	600-10S	2	208 (458)
	600-12X	2	217 (478)
	600-13	2	171 (376)

DIST	COUNTY	ROUTE	KILOMETER POST TOTAL PROJECT	SHEET NO.	TOTAL SHEETS

REGISTERED CIVIL ENGINEER

July 1, 2002
PLANS APPROVAL DATE

REGISTERED PROFESSIONAL ENGINEER — Glenn DeCou — No. C34547 — Exp. 9-30-03 — CIVIL — STATE OF CALIFORNIA

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION

BICYCLE PROOF GRATE DETAILS

These "Standard Plans for Construction of Local Streets and Roads" contain units in two systems of measurement: International System of Units (SI or "metric") and United States Standard Measures shown in the parentheses (). The measurements expressed in the two systems are not necessarily equal or interchangeable. See the "Foreword" at the beginning of this publication.

NO SCALE

D77B

ATTACHMENT 17

COLUSA GENERATING STATION
COLS-1-DC-024-0001

NORTH BASIN CALCULATIONS

NORTH BASIN

DIMENSIONS AND VOLUMES OF A RECTANGULAR POND

Dimensions are calculated from the bottom dimensions and the side slope.
Volumes are calculated using the conic method.

ELEVATIONS

Bottom of Pond	0.00	FT
Sediment Cleanout	1.15	FT
Water Level	4.10	FT
Top of Pond	5.00	FT
Side Slope	3.00	H:V

Sediment Depth
1.15 FT

Freeboard
0.90 FT

BOTTOM DIMENSIONS

Length	460.00	FT
Width	150.00	FT
Area	69,000.00	SQ.FT

CLEANOUT DIMENSIONS

Length	466.90	FT
Width	156.90	FT
Area	73,256.61	SQ.FT

WATER LEVEL DIMENSIONS

Length	484.60	FT
Width	174.60	FT
Area	84,611.16	SQ.FT

TOP DIMENSIONS

Length	490.00	FT
Width	180.00	FT
Area	88,200.00	SQ.FT

DEAD SEDIMENT STORAGE VOLUME

81,785.34	CF
611,754	GAL
1.88	ACRE-FT

LIVE VOLUME

232,653.94	CF
1,740,251	GAL
5.34	ACRE-FT

TOTAL VOLUME

314,359.41	CF
2,351,408	GAL
7.22	ACRE-FT

VOLUME WITH FREEBOARD

392,019.23	CF
2,932,304	GAL
9.00	ACRE-FT

NORTH BASIN

ATTACHMENT .

COLS-1-DC-024-0001

SIMPLE RUNOFF CALCULATOR

Rainfall (in.) 2.50

	Area Description	Area (ac)	CN	CN × Area
1	Undisturbed	4.6	84	386.4
2	Switchyard	8.3	89	738.7
3	Laydown	31.8	89	2830.2
4				
5				
6				
7				

Total Area 44.7

Total Product 3955.3

Composite CN 88.5

Runoff (in.) 1.42

Live Volume = Runoff Volume (CF) **229869**

Dead Volume $= (67\ yd^3)(27\ ft^3/yd^3)(44.7\ ac)$

$= 80,862\ ft^3$

COLUSA GENERATING STATION

Orifice Calculations
(SE-2, CASQA Stormwater BMP Handbook)

Drawdown Time: 40 hours

North Basin:

$L_{basin\ @\ mid\ elev.}$	=	475	ft
$W_{basin\ @\ mid\ elev.}$	=	165	ft
$A_{basin\ @\ mid\ elev.}$	=	78375	ft^2
H	=	4.1	ft
H_O	=	1.15	ft
C	=	0.6	
Orifice Area (a)	=	$((1.75*10^{-6})*A*(H-H_O)^{0.5}) \div C$	
	=	0.39	ft^2
	=	56.54	in^2
Orifice Diameter	=	**8.49**	in
▶	Try	**8.5**	in
→ Orifice Area (a)	=	56.72	in^2
	=	0.39	ft^2
→ Drawdown Time	=	$((7*10^{-5})*A*(H-H_O)^{0.5}) \div (a*C)$	
	=	**39.87**	hours

▲ Use Orifice Diameter of **8.5 in**
since the drawdown time is within the range of 24 & 72 hours.

Worksheet for Outlet - North Basin - 10-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.01670	ft/ft
Normal Depth	2.50	ft
Diameter	2.50	ft
Discharge	28.71	ft³/s

> 17.33 release rate
∴ OK

Results

Discharge	28.71	ft³/s
Normal Depth	2.50	ft
Flow Area	4.91	ft²
Wetted Perimeter	7.85	ft
Top Width	0.00	ft
Critical Depth	1.83	ft
Percent Full	100.0	%
Critical Slope	0.02136	ft/ft
Velocity	5.85	ft/s
Velocity Head	0.53	ft
Specific Energy	3.03	ft
Froude Number	0.00	
Maximum Discharge	30.88	ft³/s
Discharge Full	28.71	ft³/s
Slope Full	0.01670	ft/ft
Flow Type	SubCritical	

10.36 + 13.94 / 2
= 17.33 cfs

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Worksheet for Outlet - North Basin - 10-yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.50	ft
Critical Depth	1.83	ft
Channel Slope	0.01670	ft/ft
Critical Slope	0.02136	ft/ft

Worksheet for Velocity Check - North Basin - 10-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.01670	ft/ft
Diameter	2.50	ft
Discharge	17.33	ft³/s

Results

Normal Depth	1.40	ft
Flow Area	2.83	ft²
Wetted Perimeter	4.23	ft
Top Width	2.48	ft
Critical Depth	1.41	ft
Percent Full	56.0	%
Critical Slope	0.01641	ft/ft
Velocity	6.12	ft/s
Velocity Head	0.58	ft
Specific Energy	1.98	ft
Froude Number	1.01	
Maximum Discharge	30.88	ft³/s
Discharge Full	28.71	ft³/s
Slope Full	0.00608	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	56.04	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for Velocity Check - North Basin - 10-yr Storm

GVF Output Data

Normal Depth	1.40	ft
Critical Depth	1.41	ft
Channel Slope	0.01670	ft/ft
Critical Slope	0.01641	ft/ft

Worksheet for Velocity Check - Broad Crested Weir - North - 10-yr

Project Description

Solve For	Crest Elevation

Input Data

Discharge		17.33	ft^3/s
Headwater Elevation		1.40	ft
Tailwater Elevation		0.00	ft
Crest Surface Type	Gravel		
Crest Breadth		26.00	ft
Crest Length		10.00	ft

Results

Crest Elevation	0.67	ft
Headwater Height Above Crest	0.73	ft
Tailwater Height Above Crest	-0.67	ft
Weir Coefficient	2.76	US
Submergence Factor	1.00	
Adjusted Weir Coefficient	2.76	US
Flow Area	7.33	ft^2
Velocity	2.36	ft/s
Wetted Perimeter	11.47	ft
Top Width	10.00	ft

< 3.5 ft/s ∴ OK

Worksheet for Velocity Check - Trapezoidal Channel - North - 10-yr

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.069	
Channel Slope	0.00100	ft/ft
Normal Depth	1.40	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft

Results

Discharge	13.02	ft^3/s
Flow Area	17.92	ft^2
Wetted Perimeter	16.26	ft
Top Width	15.60	ft
Critical Depth	0.37	ft
Critical Slope	0.10119	ft/ft
Velocity	0.73	ft/s
Velocity Head	0.01	ft
Specific Energy	1.41	ft
Froude Number	0.12	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.40	ft
Critical Depth	0.37	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.10119	ft/ft

ATTACHMENT 18

COLUSA GENERATING STATION
COLS-1-DC-024-0001

SOUTH BASIN CALCULATIONS

SOUTH BASIN

ATTACHMENT .

COLS-1-DC-024-0001

DIMENSIONS AND VOLUMES OF A RECTANGULAR POND

Dimensions are calculated from the bottom dimensions and the side slope.
Volumes are calculated using the conic method.

ELEVATIONS

Bottom of Pond	0.00	FT
Sediment Cleanout	1.00	FT
Water Level	3.25	FT
Top of Pond	4.25	FT
Side Slope	3.00	H:V

Sediment Depth
1.00 FT

Freeboard
1.00 FT

BOTTOM DIMENSIONS

Length	250.00	FT
Width	100.00	FT
Area	25,000.00	SQ.FT

CLEANOUT DIMENSIONS

Length	256.00	FT
Width	106.00	FT
Area	27,136.00	SQ.FT

WATER LEVEL DIMENSIONS

Length	269.50	FT
Width	119.50	FT
Area	32,205.25	SQ.FT

TOP DIMENSIONS

Length	275.50	FT
Width	125.50	FT
Area	34,575.25	SQ.FT

DEAD SEDIMENT STORAGE VOLUME

26,060.70	CF
194,934	GAL
0.60	ACRE-FT

LIVE VOLUME

66,677.56	CF
498,748	GAL
1.53	ACRE-FT

TOTAL VOLUME

92,711.76	CF
693,484	GAL
2.13	ACRE-FT

VOLUME WITH FREEBOARD

126,048.78	CF
942,845	GAL
2.89	ACRE-FT

SOUTH BASIN

ATTACHMENT .

COLS-1-DC-024-0001

SIMPLE RUNOFF CALCULATOR

Rainfall (in.) 2.50

	Area Description	Area (ac)	CN	CN × Area
1	Road	0.5	93	46.5
2	Dirt	10.8	89	961.2
3				
4				
5				
6				
7				

Total Area 11.3 Total Product 1007.7

Composite CN 89.2

Runoff (in.) 1.47

Live Volume = Runoff Volume (CF) **60215**

Dead Volume = (67)(27)(11.3)

= 20,442 ft^3

COLUSA GENERATING STATION

Orifice Calculations
(SE-2, CASQA Stormwater BMP Handbook)

Drawdown Time: 40 hours

South Basin:

$L_{basin\ @\ mid\ elev.}$	=	262.75	ft
$W_{basin\ @\ mid\ elev.}$	=	112.75	ft
$A_{basin\ @\ mid\ elev.}$	=	29625	ft^2
H	=	4.25	ft
H_O	=	1	ft
C	=	0.6	

Orifice Area (a) = $((1.75*10^{-6})*A*(H-H_O)^{0.5}) \div C$

	=	0.16	ft^2
	=	22.43	in^2
Orifice Diameter	=	**5.35**	in
►	Try	**5.25**	in
→ Orifice Area (a)	=	21.64	in^2
	=	0.15	ft^2

→ Drawdown Time = $((7*10^{-5})*A*(H-H_O)^{0.5}) \div (a*C)$

= **41.47** hours

▲ Use Orifice Diameter of **5.25 in**
since the drawdown time is within the range of 24 & 72 hours.

Worksheet for Outlet - South Basin - 10-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.00930	ft/ft
Normal Depth	2.50	ft
Diameter	2.50	ft
Discharge	21.42	ft³/s

> 14.75 cfs release rate
∴ OK

Results

Discharge	21.42	ft³/s
Normal Depth	2.50	ft
Flow Area	4.91	ft²
Wetted Perimeter	7.85	ft
Top Width	0.00	ft
Critical Depth	1.57	ft
Percent Full	100.0	%
Critical Slope	0.01785	ft/ft
Velocity	4.36	ft/s
Velocity Head	0.30	ft
Specific Energy	2.80	ft
Froude Number	0.00	
Maximum Discharge	23.05	ft³/s
Discharge Full	21.42	ft³/s
Slope Full	0.00930	ft/ft
Flow Type	SubCritical	

13.94/2 + 7.78
= 14.75 cfs

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Worksheet for Outlet - South Basin - 10-yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.50	ft
Critical Depth	1.57	ft
Channel Slope	0.00930	ft/ft
Critical Slope	0.01785	ft/ft

Worksheet for Velocity Check - South Basin - 10-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.024	
Channel Slope	0.00930	ft/ft
Diameter	2.50	ft
Discharge	14.75	ft³/s

Results

Normal Depth	1.52	ft
Flow Area	3.13	ft²
Wetted Perimeter	4.48	ft
Top Width	2.44	ft
Critical Depth	1.29	ft
Percent Full	61.0	%
Critical Slope	0.01567	ft/ft
Velocity	4.71	ft/s
Velocity Head	0.34	ft
Specific Energy	1.87	ft
Froude Number	0.73	
Maximum Discharge	23.05	ft³/s
Discharge Full	21.42	ft³/s
Slope Full	0.00441	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	60.97	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for Velocity Check - South Basin - 10-yr Storm

GVF Output Data

Normal Depth	1.52	ft
Critical Depth	1.29	ft
Channel Slope	0.00930	ft/ft
Critical Slope	0.01567	ft/ft

Worksheet for Velocity Check - Broad Crested Weir - South - 10-yr

Project Description

Solve For	Crest Elevation

Input Data

Discharge		14.75	ft^3/s
Headwater Elevation		1.52	ft
Tailwater Elevation		0.00	ft
Crest Surface Type	Gravel		
Crest Breadth		16.00	ft
Crest Length		10.00	ft

Results

Crest Elevation	0.86	ft	
Headwater Height Above Crest	0.66	ft	
Tailwater Height Above Crest	-0.86	ft	
Weir Coefficient	2.74	US	
Submergence Factor	1.00		
Adjusted Weir Coefficient	2.74	US	
Flow Area	6.61	ft^2	
Velocity	2.23	ft/s	< 3.5 ft/s ∴ OK
Wetted Perimeter	11.32	ft	
Top Width	10.00	ft	

Worksheet for Velocity Check - Trapezoidal Channel - South - 10-yr

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.069	
Channel Slope	0.00100	ft/ft
Normal Depth	1.52	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft

Results

Discharge	15.07	ft³/s
Flow Area	19.82	ft²
Wetted Perimeter	16.80	ft
Top Width	16.08	ft
Critical Depth	0.40	ft
Critical Slope	0.09840	ft/ft
Velocity	0.76	ft/s
Velocity Head	0.01	ft
Specific Energy	1.53	ft
Froude Number	0.12	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.52	ft
Critical Depth	0.40	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.09840	ft/ft

ATTACHMENT 19

COLUSA GENERATING STATION
COLS-1-DC-024-0001

WEST BASIN CALCULATIONS

WEST BASIN

DIMENSIONS AND VOLUMES OF A RECTANGULAR POND

Dimensions are calculated from the bottom dimensions and the side slope.
Volumes are calculated using the conic method.

ELEVATIONS

Bottom of Pond	0.00	FT
Sediment Cleanout	1.00	FT
Water Level	4.00	FT
Top of Pond	5.00	FT
Side Slope	3.00	H:V

Sediment Depth
1.00 FT

Freeboard
1.00 FT

BOTTOM DIMENSIONS

Length	310.00	FT
Width	100.00	FT
Area	31,000.00	SQ.FT

DEAD SEDIMENT STORAGE VOLUME

32,239.95 CF
241,155 GAL
0.74 ACRE-FT

CLEANOUT DIMENSIONS

Length	316.00	FT
Width	106.00	FT
Area	33,496.00	SQ.FT

LIVE VOLUME

112,158.08 CF
838,942 GAL
2.57 ACRE-FT

WATER LEVEL DIMENSIONS

Length	334.00	FT
Width	124.00	FT
Area	41,416.00	SQ.FT

TOTAL VOLUME

144,329.99 CF
1,079,588 GAL
3.31 ACRE-FT

TOP DIMENSIONS

Length	340.00	FT
Width	130.00	FT
Area	44,200.00	SQ.FT

VOLUME WITH FREEBOARD

187,027.02 CF
1,398,962 GAL
4.29 ACRE-FT

WEST BASIN

ATTACHMENT .

COLS-1-DC-024-0001

SIMPLE RUNOFF CALCULATOR

Rainfall (in.) 2.50

	Area Description	Area (ac)	CN	CN × Area
1	Road	14.6	93	1357.8
2	Dirt	1	89	89
3				
4				
5				
6				
7				

Total Area 15.6

Total Product 1446.8

Composite CN 92.7

Runoff (in.) 1.76

Live Volume = Runoff Volume (CF) **99492**

Dead Volume = (67)(27)(15.6)

= 28,220 ft^3

COLUSA GENERATING STATION

Orifice Calculations
(SE-2, CASQA Stormwater BMP Handbook)

Drawdown Time: 40 hours

West Basin:

$L_{basin\ @\ mid\ elev.}$	=	325	ft
$W_{basin\ @\ mid\ elev.}$	=	115	ft
$A_{basin\ @\ mid\ elev.}$	=	37375	ft^2
H	=	4	ft
H_O	=	1	ft
C	=	0.6	

Orifice Area (a) = $((1.75*10^{-6})*A*(H-H_O)^{0.5}) \div C$

= 0.19 ft^2
= 27.19 in^2

Orifice Diameter = **5.89** in

► Try **5.75** in
→ Orifice Area (a) = 25.95 in^2
= 0.18 ft^2

→ Drawdown Time = $((7*10^{-5})*A*(H-H_O)^{0.5}) \div (a*C)$

= **41.90** hours

▲ Use Orifice Diameter of **5.75 in**
since the drawdown time is within the range of 24 & 72 hours.

COLUSA GENERATING STATION

Detention Calculations
(Rational Method)

10-yr Storm Event:

Q_{post} =	40.88	cfs
Q_{power_block} =	19.09	cfs
$Q_{historic}$ =	48.1	cfs
Q_{detain} =	11.87	cfs
$Q_{release}$ =	7.22	cfs
A_{power_block} =	15.6	acres
C =	0.93	

Duration *(min)*	I_{10yr} *(in/hr)*	***Q*** *(cfs)*	Q_{Δ} *(cfs)*	***Volume*** *(ft^3)*
10	1.45	21.04	13.82	8290
20	1.1	15.96	8.74	10487
30	0.95	13.78	6.56	11813
40	0.8	11.61	4.39	10527
50	0.7	10.16	2.94	8807
60	0.6	8.70	1.48	5345
70	0.55	7.98	0.76	3189
80	0.53	7.69	0.47	2252
90	0.51	7.40	0.18	967
100	0.49	7.11	-0.11	-666

Design Volume = **11813** ft^3

$Q_{detain} = (Q_{post} + Q_{power\_block}) - Q_{historic}$

$Q_{release} = Q_{power\_block} - Q_{detain}$

$Q = C * I_{10yr} * A_{power\_block}$

$Q_{\Delta} = Q - Q_{release}$

$Volume = Q_{\Delta} * Duration$

Worksheet for Outlet - West Basin - 100-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00590	ft/ft
Normal Depth	2.50	ft
Diameter	2.50	ft
Discharge	31.50	ft³/s

> 19.72 cfs release rate
∴ OK

Results

Discharge	31.50	ft³/s
Normal Depth	2.50	ft
Flow Area	4.91	ft²
Wetted Perimeter	7.85	ft
Top Width	0.00	ft
Critical Depth	1.91	ft
Percent Full	100.0	%
Critical Slope	0.00678	ft/ft
Velocity	6.42	ft/s
Velocity Head	0.64	ft
Specific Energy	3.14	ft
Froude Number	0.00	
Maximum Discharge	33.89	ft³/s
Discharge Full	31.50	ft³/s
Slope Full	0.00590	ft/ft
Flow Type	SubCritical	

(79.59 + 32.47) − 99.31
= 12.75
⇒ 32.47 − 12.75
= 19.72 cfs

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Worksheet for Outlet - West Basin - 100-yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.50	ft
Critical Depth	1.91	ft
Channel Slope	0.00590	ft/ft
Critical Slope	0.00678	ft/ft

Worksheet for Velocity Check - Outlet - West Basin - 100-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00590	ft/ft
Diameter	2.50	ft
Discharge	19.72	ft³/s

Results

Normal Depth	1.43	ft
Flow Area	2.91	ft²
Wetted Perimeter	4.30	ft
Top Width	2.47	ft
Critical Depth	1.51	ft
Percent Full	57.3	%
Critical Slope	0.00505	ft/ft
Velocity	6.77	ft/s
Velocity Head	0.71	ft
Specific Energy	2.15	ft
Froude Number	1.10	
Maximum Discharge	33.89	ft³/s
Discharge Full	31.50	ft³/s
Slope Full	0.00231	ft/ft
Flow Type	SuperCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	57.34	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for Velocity Check - Outlet - West Basin - 100-yr Storm

GVF Output Data

Normal Depth	1.43	ft
Critical Depth	1.51	ft
Channel Slope	0.00590	ft/ft
Critical Slope	0.00505	ft/ft

Worksheet for Velocity Check-Outlet-Broad Crested Weir-West-100-yr

Project Description

Solve For	Crest Elevation

Input Data

Discharge		19.72	ft^3/s
Headwater Elevation		1.43	ft
Tailwater Elevation		0.00	ft
Crest Surface Type	Gravel		
Crest Breadth		16.00	ft
Crest Length		10.00	ft

Results

Crest Elevation	0.63	ft	
Headwater Height Above Crest	0.80	ft	
Tailwater Height Above Crest	-0.63	ft	
Weir Coefficient	2.78	US	
Submergence Factor	1.00		
Adjusted Weir Coefficient	2.78	US	
Flow Area	7.96	ft^2	
Velocity	2.48	ft/s	< 3.5 ft/s ∴ OK
Wetted Perimeter	11.59	ft	
Top Width	10.00	ft	

Worksheet for Velocity Check-Outlet-Trapezoidal Channel-West-100-yr

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.069	
Channel Slope	0.00100	ft/ft
Normal Depth	1.43	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft

Results

Discharge	13.52	ft³/s
Flow Area	18.39	ft²
Wetted Perimeter	16.40	ft
Top Width	15.72	ft
Critical Depth	0.37	ft
Critical Slope	0.10046	ft/ft
Velocity	0.74	ft/s
Velocity Head	0.01	ft
Specific Energy	1.44	ft
Froude Number	0.12	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.43	ft
Critical Depth	0.37	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.10046	ft/ft

Worksheet for Inlet - West Basin - 100-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.00500	ft/ft
Normal Depth	3.00	ft
Diameter	3.00	ft
Discharge	40.87	ft³/s

> 32.46 cfs total system flow

∴ OK

Results

Discharge	40.87	ft³/s
Normal Depth	3.00	ft
Flow Area	7.07	ft²
Wetted Perimeter	9.42	ft
Top Width	0.00	ft
Critical Depth	2.08	ft
Percent Full	100.0	%
Critical Slope	0.00729	ft/ft
Velocity	5.78	ft/s
Velocity Head	0.52	ft
Specific Energy	3.52	ft
Froude Number	0.00	
Maximum Discharge	43.97	ft³/s
Discharge Full	40.87	ft³/s
Slope Full	0.00500	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	100.00	%

Worksheet for Inlet - West Basin - 100-yr Storm

GVF Output Data

Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.00	ft
Critical Depth	2.08	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00729	ft/ft

Worksheet for Velocity Check - Inlet - West Basin - 100-yr Storm

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.015	
Channel Slope	0.00500	ft/ft
Diameter	3.00	ft
Discharge	32.46	ft^3/s

Results

Normal Depth	2.02	ft
Flow Area	5.06	ft^2
Wetted Perimeter	5.77	ft
Top Width	2.81	ft
Critical Depth	1.85	ft
Percent Full	67.3	%
Critical Slope	0.00644	ft/ft
Velocity	6.42	ft/s
Velocity Head	0.64	ft
Specific Energy	2.66	ft
Froude Number	0.84	
Maximum Discharge	43.97	ft^3/s
Discharge Full	40.87	ft^3/s
Slope Full	0.00315	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	67.30	%
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s

Worksheet for Velocity Check - Inlet - West Basin - 100-yr Storm

GVF Output Data

Normal Depth	2.02	ft
Critical Depth	1.85	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00644	ft/ft

Worksheet for Velocity Check-Inlet-Broad Crested Weir-West-100-yr

Project Description

Solve For	Crest Elevation

Input Data

Discharge		32.46	ft^3/s
Headwater Elevation		2.02	ft
Tailwater Elevation		0.00	ft
Crest Surface Type	Gravel		
Crest Breadth		26.00	ft
Crest Length		12.00	ft

Results

Crest Elevation	1.05	ft	
Headwater Height Above Crest	0.97	ft	
Tailwater Height Above Crest	-1.05	ft	
Weir Coefficient	2.82	US	
Submergence Factor	1.00		
Adjusted Weir Coefficient	2.82	US	
Flow Area	11.67	ft^2	
Velocity	2.78	ft/s	< 3.5 ft/s ∴ OK
Wetted Perimeter	13.94	ft	
Top Width	12.00	ft	

Worksheet for Velocity Check-Inlet-Trapezoidal Channel-West-100-yr

Project Description

Friction Method	Manning Formula
Solve For	Discharge

Input Data

Roughness Coefficient	0.069	
Channel Slope	0.00100	ft/ft
Normal Depth	1.05	ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	12.00	ft

Results

Discharge	9.31	ft³/s
Flow Area	14.81	ft²
Wetted Perimeter	16.70	ft
Top Width	16.20	ft
Critical Depth	0.26	ft
Critical Slope	0.11139	ft/ft
Velocity	0.63	ft/s
Velocity Head	0.01	ft
Specific Energy	1.06	ft
Froude Number	0.12	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.05	ft
Critical Depth	0.26	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.11139	ft/ft

ATTACHMENT 20

COLUSA GENERATING STATION
COLS-1-DC-024-0001

PERMISSIBLE VELOCITIES FOR EARTH-LINED CHANNELS

Permissible Velocities For Earth-Lined Channels	
Soil Type or Lining (earth, no vegetation)	***Permissible Velocity (fps)***
Find Sand (noncolloidal)	2.0
Sandy Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Silty Clay	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (noncolloidal)	5.5
Alluvial Silts (noncolloidal)	3.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5
Shales and Hard Pans	6.0

City of Vacaville, Storm Water Management Plan, Design Standard