APPENDICES

A. Contractor's Request for Construction Staking
B. Geotechnical Engineering Investigation entitled, PROPOSED NEW RECHARGE BASIN AND SEWER IMPROVEMENTS by BSK ASSOCIATES, dated JANUARY 15TH, 2024.
C. Geotechnical Engineering Investigation entitled, PROPOSED RECHARGE BASIN AND SEWER IMPROVEMENTS – NEW SIPHON by BSK ASSOCIATES, dated February 27TH, 2025.
D. Stormwater Pollution Prevention Plan (Bidding Purposes Only)

APPENDIX A

CONSTRACTOR'S REQUEST FOR CONSTRUCTION STAKING

EST. 1968
PROVOST& PRITCHARD
CONSULTING GROUP
An Employee Owned Company

CONSTRUCTION STAKING REQUEST FORM

Project Name: _____

ATTN: _____ **Date:** _____

P&P Proj. No.: _____ Phase: _____ PM: _____

Prime Contractor: _____ Construction Manager: _____

*Note: Staking requests must come from Prime Contractor only, subcontractor submittals will not be recognized.

Date Stakes Needed On-site: _____ **Requested by:** _____
(72 Working Hours Notice Required) (name and contact phone no.)

Breifly Describe Staking Request: _____

_____

_____

No. 1 Request (item to be staked): _____

Identify: ☐ Rough Grade ☐ Finish Grade ☐ Restake ☐ Other: _____

Feature: ☐ EP ☐ TFC ☐ FL ☐ Other: _____

Offset: ☐ 3' ☐ 5' ☐ 10' ☐ Corner Staking/Control ____ X ____
☐ Other Offset (explain): _____

Stations: ☐ 50' ☐ 100' ☐ 300' ☐ Other: _____

No. 2 Request (item to be staked): _____

Identify: ☐ Rough Grade ☐ Finish Grade ☐ Restake ☐ Other: _____

Feature: ☐ EP ☐ TFC ☐ FL ☐ Other: _____

Offset: ☐ 3' ☐ 5' ☐ 10' ☐ Corner Staking/Control ____ X ____
☐ Other Offset (explain): _____

Stations: ☐ 50' ☐ 100' ☐ 300' ☐ Other: _____

No. 3 Request (item to be staked): _____

Identify: ☐ Rough Grade ☐ Finish Grade ☐ Restake ☐ Other: _____

To Feature: ☐ EP ☐ TFC ☐ FL ☐ Other: _____

Offset: ☐ 3' ☐ 5' ☐ 10' ☐ Corner Staking/Control ____ X ____
☐ Other Offset (explain): _____

Stations: ☐ 50' ☐ 100' ☐ 300' ☐ Other: _____

Notes: _____

_____

_____

APPENDIX B

GEOTECHNICAL ENGINEERING INVESTIGATION ENTITLED, PROPOSED NEW RECHARGE BASIN AND SEWER IMPROVEMENTS BY BSK ASSOCIATES, DATED JANUARY 15TH, 2024.

GEOTECHNICAL ENGINEERING INVESTIGATION REPORT
PROPOSED NEW RECHARGE BASIN AND SEWER IMPROVEMENTS
LOS BANOS
MERCED COUNTY, CALIFORNIA

BSK PROJECT G00001262

PREPARED FOR:

PROVOST & PRITCHARD CONSULTING GROUP
455 W FIR AVENUE
CLOVIS, CALIFORNIA 93611

JANUARY 15, 2024

GEOTECHNICAL ENGINEERING INVESTIGATION REPORT
PROPOSED NEW RECHARGE BASIN AND SEWER IMPROVEMENTS
LOS BANOS
MERCED COUNTY, CALIFORNIA

Prepared for:

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BSK Project: G00001262

January 15, 2024

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1 INTRODUCTION

1.1 General

This report presents the results of our geotechnical engineering investigation for the proposed Improvements outlined in the project description.

In the event that significant changes occur in the design or location of the proposed improvements, the conclusions and recommendations presented in this report will not be considered valid unless the changes are reviewed by BSK and the conclusions and recommendations are modified or verified in writing as necessary.

1.2 Project Description

We understand the project consists of a new recharge basin and sanitary sewer replacement projects west of the San Luis Drain and Santa Fe Grade. The proposed recharge basin is planned to be placed east of Los Banos, California, and west of Santa Fe Grade and the San Luis Canal. The basin is anticipated to be less than 10 feet below grade. Basin embankment slopes are anticipated to be composed of material generated on-site. Slopes are anticipated to be no steeper than 2H:1V (Horizontal:Vertical). Additionally, we anticipate turnouts to be located on each side of the basin with pump stations and necessary pipelines.

The proposed sewer replacement is anticipated to include a 24 to 36 inch diameter pipeline approximately 20 feet below grade. The sewer is anticipated to utilize trenchless excavation methods to cross three canals.

1.3 Purpose and Scope of Services

The purpose of the geotechnical investigation is to assess soil conditions at the project site and provide geotechnical engineering recommendations for use by the project designers. The scope of the investigation included a field exploration, laboratory testing, engineering analysis, and preparation of this report.

2 FIELD INVESTIGATION AND LABORATORY TESTING

2.1 General

The field exploration, conducted on November 1 through November 3, 2023, consisted of a site reconnaissance and drilling ten (10) exploratory test borings to a maximum depth of approximately 16.5 to 51.5 feet below ground surface (bgs). The test borings were drilled with a truck-mounted drill rig, equipped with 8-inch augers. Details of the field exploration and the boring logs are provided in Appendix A.

At five feet below the first encountered groundwater, a "grab" water sample was obtained by bailing out water from within the hollow stem auger at borings B-1, B-3, B-5, B-6, B-7 and B-8.

2.2 Laboratory Testing

Laboratory testing of selected soil samples were performed to evaluate certain physical, chemical, and engineering characteristics and properties. The testing program included: gradation, in-situ moisture and density, collapse potential, direct shear, and corrosion potential. The in-situ moisture and dry density test results are presented on the boring logs in Appendix A. Descriptions of the laboratory test methods and test results are provided in Appendix B.

Analytical testing of water sampled was performed as requested and test results are presented in Appendix D.

3 SITE CONDITIONS

3.1 Site Description

The proposed improvements will be situated in Merced County, California. The project site was located east of Los Banos, California, and west of Santa Fe Grade.

The proposed basins are located in an area planted with agricultural fields. The proposed area is surrounded by the unlined canals: Santa Fe Canal and San Luis Canal. A concrete lined irrigation ditch runs along the middle of the proposed basin area, parallel to Santa Fe Grade (northwest to southeast). The irrigation ditch is less than 5 feet deep, and the canal depths are unknown. Unpaved roadways run along the canal and ditch levees.

The proposed sewer pipeline alignment runs diagonally from Rockport Drive and Westminster Way extending northeast across the project site to the wastewater treatment access road across the Santa Fe Canal. The alignment crosses the Santa Fe Canal, the San Luis Drain, and the San Luis Canal. The project site was bound to the north and east by the Santa Fe Canal with agricultural fields beyond, to the south by agricultural fields, and to the west by a residential area. The project site contained overhead powerlines, access roads, agricultural pumps, and unlined canals.

3.2 Subsurface Conditions

The near surface soil consisted of sandy clay, clayey sand and sandy silt, underlain by sandy silt, silty sand and poorly graded sand to the maximum depth explored (51.5 feet bgs). The boring logs in Appendix A provide a more detailed description of the soils encountered in each boring, including the applicable Unified Soil Classification System symbols. The approximate locations of the soil borings are shown on the Boring Location Map (Figure 2).

Near surface soils exhibit a low to moderate expansion potential, and low collapse potential.

The soil types encountered in the upper 10 to 20 feet were predominantly sandy silts and clays. Based on these encountered soil types BSK recommends a Lanes Weighted Creep Factor (C_W) of 4.0.

3.3 Groundwater

Groundwater was encountered as shallow as 20 feet in the test borings during our field exploration, November 1 through November 3, 2023. The California Department of Water Resources indicates the depth to recent regional groundwater at the project site is greater than 25 feet bgs. However, fluctuations in the groundwater level or the presence of perched groundwater may occur due to variations in rainfall, irrigation, seasonal factors, pumping from wells and other factors that were not evident at the time of our investigation. Groundwater is not anticipated to affect construction of the proposed improvements above 20 feet bgs. For construction extending below groundwater, dewatering will be necessary.

4 CONCLUSIONS AND RECOMMENDATIONS

4.1 General

Based upon the data collected during this investigation and from a geotechnical engineering standpoint, it is our opinion that there are no soil conditions that would preclude the construction of the proposed improvements, provided the recommendations presented in this report are incorporated into the project design and construction.

4.2 Soil Corrosivity

One (1) surface soil sample obtained from the Site was tested to provide a preliminary screening of the potential for concrete deterioration or steel corrosion due to attack by soil-borne soluble salts. The test results are presented in Appendix B. The soil was evaluated for minimum resistivity and pH (CT 643), soluble sulfate (CT 417), and chlorides (CT 422).

The water-soluble sulfate content severity class is considered negligible to concrete. (Exposure Category S0 per Table 19.3.1.1 of ACI 318-19). The water-soluble chloride content exposure class is C0 per Table 19.3.1.1 of ACI 318-19. The site soils minimum resistivity is low and is considered very severely corrosive to buried metal. Buried reinforcing steel protection must be provided with the minimum concrete cover required by the American Concrete Institute (ACI) Building Code for Structural Concrete, ACI 318, Chapter 7.7. Buried metal conduits, ferrous metal pipes, and exposed steel must have protective coatings in accordance with the manufacturer's specifications.

4.3 Seismic Design Criteria

There are no known active fault zones within the vicinity of the project site. In accordance with Section 1613.2.2 of the 2022 California Building Code (CBC) and Table 20.3-1 of ASCE 7-16, the site can be classified as Site Class D (default).

Use of the 2022 California Building Code (CBC) seismic design criteria is considered appropriate and the following parameters are considered applicable for the structural design of foundations.

Table 1: Seismic Design Parameters

Seismic Design Parameter	2022 CBC Value		Reference
MCE Mapped Spectral Acceleration (g)	S_S = 1.11	S_1 = 0.384	USGS Mapped Value
Amplification Factors (Site Class D)	F_a = 1.056	F_v = null[1](1.916)[2]	ASCE Table 11.4
Site Adjusted MCE Spectral Acceleration (g)	S_{MS} = 1.172	S_{M1} = null[1](0.736)[2]	ASCE Equations 11.4.1-2
Design Spectral Acceleration (g)	S_{DS} = 0.781	S_{D1} = null[1] (0.490)[2]	ASCE Equations 11.4.1-4
Geometric Mean PGA (g)	PGA_M = 0.523		Section 11.8.3, ASCE 7-16
Site Short Period – T_s (seconds)	T_s = 0.628		$T_s = S_{D1}/ S_{DS}$
Site Long Period – T_L (seconds)	T_L = 8		USGS Mapped Value

Notes: [1] Requires site-specific ground motion procedure or exception as per ASCE 7-16 Section 11.4.8.

[2] Values from ASCE 7-16 supplement shall only be used to calculate T_s. Values provided based on use of exception, as provided in Section 11.4.8.2 to Site-Specific Ground Motion Procedures and assumes the value of the seismic response coefficient C_s is determined by Eq. 12.8-2 for values of $T \leq 1.5T_s$ and taken as equal to 1.5 times the value computed in accordance with either Eq. 12.8-3 for $T_L \geq T > 1.5T_s$ or Eq. 12.8-4 for $T > T_L$. The 1.5 increase has not been applied to the values presented.

As shown above, the short period design spectral response acceleration coefficient, S_{DS}, is greater than 0.5, therefore the Site lies in Seismic Design Category D as specified in Section 1613.2.5 of the 2022 CBC. The long period design spectral response acceleration coefficient, S_{D1}, is greater than 0.2, therefore the Site lies in Seismic Design Category D as specified in Section 1613.2.5 of the 2022 CBC. In accordance with the 2022 CBC, each structure shall be assigned to the more severe seismic design category in accordance with Table 1613.2.5(1) or 1613.2.5(2), irrespective of the fundamental period of vibration of the structure.

4.4 Slope Stability Analysis

The maximum depth for the proposed basin embankment is anticipated to be 10 feet. The gradient of the proposed basin is anticipated to be 2:1 (H:V). The stability of the cut and fill slopes was analyzed for the static and pseudo-static condition using Janbu's and Bishop's Simplified Method of Slices and modeled

in the computer program, Slide v7.0. The slope model was analyzed for stability using circular slip surfaces originating and terminating at critical points along the cross sections analyzed. The inputs required for the site include slope geometry, subsurface profile data, groundwater conditions, horizontal ground acceleration, as well as constraints on the upper and lower limits of the search region for the critical slip circle, numbers and locations of initiation and termination points of trial surfaces, and number of trial surfaces for each initiation point.

The values used in our analysis are summarized in the following table:

Table 2: Slope Stability Soil Parameters

Material	Depth (ft)	Unit Weight (pcf)	Cohesion (psf)	Friction Angle (degrees)
Sandy Clay (CL)	0-10	120	330	18
Poorly Graded Sand (SP)	10-15	120	0	35

The horizontal ground motion site coefficient of 0.174g (1/3 of PGA_M) was used in the slope stability analysis. Vertical ground motions and groundwater conditions were not considered in the analysis. For each cross section, 25,640 randomly generated slip circles were analyzed for the critical factor of safety.

A summary of the critical factors of safety is provided in the following table:

Table 3: Critical Factors of Safety
Maximum Slope Height – 10'

Maximum Slope (H:V) and Method	STATIC	PSEUDO-STATIC
2:1	2.2	1.6

Based upon the data collected during this investigation and from a geotechnical engineering standpoint, it is our opinion that there are no soil conditions that would preclude the construction of the proposed basin provided that the recommendations presented in this report are incorporated into the project design and construction. The engineered fill must be placed in accordance with Section 4.5 of this report. The proposed basin may be designed/constructed with a maximum depth of 10 feet below ground surface with inboard slopes of 2H:1V or flatter.

4.5 Site Preparation and Earthwork Construction

The following procedures must be implemented during site preparation for the proposed improvements. It should be noted that references to maximum dry density, optimum moisture content, and relative compaction are based on ASTM D1557 (latest test revision) laboratory test procedures.

1. Prior to any site grading, all miscellaneous surface obstructions must be removed from the improvement area. Near surface soils containing vegetation, roots, organics, or other objectionable material must be stripped to a depth of at least 3-inches to expose a clean soil surface. Surface strippings must not be incorporated into engineered fill unless the organic content is less than 3 percent by weight (ASTM D2974).

2. Within the area of the planned improvements, remove existing vegetation, underground utilities, and debris to expose a clean soil surface free of deleterious material.

   Existing utilities or irrigation pipes must be removed to a point at least 5-feet horizontally outside the proposed improvement area. Resultant cavities must be backfilled with engineered fill. Abandoned pipelines to remain that are less than 2 inches in diameter must be capped at the cutoff point, while pipelines greater than 2 inches in diameter must be filled with a 1-sack sand-cement slurry.

3. Soil disturbed as a result of undocumented fill, debris, demolition, animal burrows, and abandoned underground structures must be excavated to expose undisturbed native soil.

4. Following the required stripping, and/or removal of underground structures, the exposed soil surface in proposed at-grade improvement areas must be over-excavated uniformly to a depth of 24 inches below existing site grade or 12 inches below the bottom of the proposed foundation or embankment, whichever is deeper. The over-excavation must extend at least 5 feet laterally beyond the outside edge of the proposed foundation or areas to receive fill, whichever distance is greater. The exposed subgrade must be proof-rolled under the observation of a BSK field representative to detect soft or pliant areas. Soft or pliant areas must be over-excavated to firm native soil. The exposed surface must be scarified at minimum of 8 inches, uniformly moisture conditioned to 2 percent above optimum moisture, and compacted to 90 percent relative compaction.

5. For new embankments, a minimum 5-foot-wide keyway must be placed below the proposed embankments. The keyway should extend an additional 1 foot below over-excavation. Over-excavation is not necessary for cut areas greater than 2 feet in depth. The over-excavation must extend at least 3 feet laterally beyond the outside edge of the proposed areas to receive fill.

6. Engineered fill must consist of non-expansive soil (EI < 20), moisture conditioned to at or above optimum moisture, and compacted to 90 percent relative compaction. Excavated soils, free of deleterious substances (organic matter, demolition debris, tree roots, etc.), with at least 30 percent passing the No. 200 sieve, and with less than 3 percent organic content by weight, may be reused as engineered fill for the backfill.

7. Engineered fill must be placed in uniform layers not exceeding 8-inches in loose thickness, moisture-conditioned and compacted as recommended above. Acceptance of engineered fill placement must be based on both moisture content at time of compaction and relative compaction.

8. Imported fill materials must be free of deleterious substances and have less than 3 percent organic content by weight. The project specifications must require the contractor to contact BSK for review

of the proposed import fill materials for conformance with these recommendations at least two weeks prior to importing to the site, whether from on-site or off-site borrow areas. Imported fill soils must be non-hazardous and be derived from a single, consistent soil type source conforming to the following criteria:

Maximum Particle Size:	3-inches
Percent Passing #4 Sieve:	65 – 100
Percent Passing #200 Sieve:	30 – 45
Plasticity Index:	less than 12
Expansion Index:	< 20
Low Corrosion Potential:	
Soluble Sulfates:	< 1,500 mg/kg
Soluble Chlorides:	< 300 mg/kg
Soil Resistivity:	> 2,000 ohm-cm

Grading operations must be scheduled as to avoid working during periods of inclement weather. Should these operations be performed during or shortly following periods of inclement weather, unstable soil conditions may result in the soils exhibiting a "pumping" condition. This condition is caused by excess moisture, in combination with compaction, resulting in saturation and near zero air voids in the soils. If this condition occurs, the affected soils must be over-excavated to the depth at which stable soils are encountered and replaced with suitable soils compacted as engineered fill. Alternatively, the Contractor may proceed with grading operations after utilizing a method to stabilize the soil subgrade, which must be subject to review by BSK prior to implementation.

4.6 Shallow, Mat, and Pole-Type Foundations

Provided the recommendations contained in this report are implemented during design and construction, it is our opinion that the proposed structures can be supported on shallow, mat, or pole-type foundations. A structural engineer must evaluate reinforcement and embedment depth based on the requirements for the structural loadings.

4.6.1 Shallow Foundations

The proposed structures may be supported on reinforced concrete spread footings bearing on engineered fill. The allowable bearing pressure applies to the dead load plus live load (DL + LL) condition. Footing design must follow the criteria listed below:

Table 4: Allowable Bearing Pressure		
	Minimum Footing Width (inches)	**Allowable Bearing Capacity[1] (psf)**

Footing Embedment[2] (inches)	Continuous Footing	Isolated Spread Footing	Continuous Footing	Isolated Spread Footing
12	18	24	2,000	2,500

Note (1) – The bearing pressure can be increased one-third for transient loading such as wind or seismic.
(2) – Measure with respect to the lowest adjacent subgrade surface.

The estimated total and differential settlement for the recommended spread footings is shown below:

Table 5: Anticipated Post-Construction Settlement

Footing Type	Post-Construction Settlement (inches)	Differential Settlement (inches)	Angular Distortion
Continuous	1.0	--	0.005
Isolated	1.0	0.5	--

Isolated footing differential settlement is based on adjacent similarly loaded footings spaced at 30-feet. The settlement values given above are applicable to the maximum loading conditions. For loads, other than the design maximum loads, the settlements can be decreased proportionally.

4.6.2 Mat Foundations

The proposed improvements may be supported on a thickened mat/slab foundation. The foundation may be designed for a maximum allowable bearing pressure of 1,500 psf (DL + LL). Estimated total settlement for mat/slabs is approximately 1.0 inch. Differential settlement across mat/slab foundations is anticipated to be on the order of about half of the total settlement over the length of the mat foundation. The weight of the concrete should be included in evaluating the contact pressure at the base of mat/slab foundations. The weight of embedded concrete can be reduced by the unit weight of soil times the depth of embedded concrete.

Mat foundations must be a minimum of 4-inches thick and must be supported on a compacted subgrade prepared in accordance with the "Site Preparation and Earthwork Construction" section of this report. In order to regulate cracking of the slabs, construction joints and/or saw-cut control joints must be provided in each direction at a maximum spacing of 10 feet on centers along with steel reinforcement as recommended by the project's Structural Engineer. Control joints must have a minimum depth of one-quarter of the slab thickness. It is recommended that steel reinforcement used in concrete slabs-on-grade consist of steel rebar. Structural concrete slabs-on-grade may be designed using an unadjusted long-term Modulus of Subgrade Reaction (Ks) of 150 pounds per cubic inch (pci) constructed on a properly

compacted subgrade or engineered fill. This value is based on the correlations to soil strength using one foot by one-foot plate-load tests and should therefore be scaled (adjusted) to the actual slab width. The adjusted Ks value can be obtained by multiplying the value provided above by $[(B+B_1)/(2B)]^2$, where B is the slab width in feet and B_1 is 1 foot (width of a one foot by one foot plate-load test apparatus).

4.6.3 Pole Type Foundations

The structures may be supported on pole-type foundations such as driven piles or drilled piers. This type of foundation should be designed in accordance with Section 1807.3 of the 2022 CBC. However, it is recommended that an allowable lateral soil bearing pressure of 120 psf per foot of embedment be used to develop parameters S_1 and S_3 rather than one of the values given in Table 1806.2. This value includes a factor of safety of 2. Piles should be placed a minimum distance from the top of the basin equivalent to the depth of the pile below grade, or a reduction in lateral pile capacity will be required. The upper one foot of the soil should be ignored when calculating the minimum embedment depth. The lateral bearing pressure shall be permitted to be increased by 1/3 where used with the alternative basic load combinations of CBC Section 1605A.3.2 that include wind or earthquake loads.

To support vertical loads applied to the pile foundations, an allowable static downward or uplift skin friction value of 300 psf (includes a factor of safety of 1.5) to support vertical loads applied to the pile foundations. Pole-type foundations should be spaced a minimum of 3 diameters apart. The total settlement of pile foundations designed in accordance with these recommendations should not exceed 0.5 inch. Skin friction may be increased by 1/3 for short term loading. The weight of the pile may be taken into consideration when determining resistance to uplift loads.

4.7 Launch and Receiving Pits

The depths of launch and receiving pits for the implementation of directional drilling are estimated to not exceed 20 feet. Soils in this upper zone, as observed in the test boring, consisted of sandy silt and sandy clay to a depth of 15 feet. Soils deeper than 15 feet bgs along the proposed pipeline consist of silty sands, poorly graded sands, and clays.

Pit excavation can be accomplished by laying slopes back not steeper than 1.5:1 (horizontal to vertical) or with the installation of a shoring system. Where sands are encountered, soils will need to be laid back flatter (at least 2H:1V, see Section 4.9) or shielding will need to be provided.

Groundwater is not anticipated to be encountered in the pits. Availability of construction dewatering provisions are not anticipated to be required for the duration of the project, provided water in the adjacent Creek is below the proposed pit elevation.

4.8 Lateral Earth Pressures and Frictional Resistance

Lateral loads applied against foundations may be resisted by a combination of passive resistance against the vertical faces of the foundations and friction between the foundation bottom and the supporting subgrade. An unfactored coefficient of friction of 0.32 may be used between soil subgrade and the cast-in-place foundation bottom. The unfactored passive pressure is presented in Table 6. The coefficient of friction and passive earth pressure values given above represent ultimate soil strength values. BSK recommends that a safety factor consistent with the design conditions be included in their usage. For resistance against lateral sliding that is countered solely by the passive earth pressure against footings or friction along the bottom of footings, a minimum safety factor of 1.5 is recommended. For stability against lateral sliding that is resisted by combined passive pressure and frictional resistance, a minimum safety factor of 2.0 is recommended. For lateral resistance against seismic loading conditions, a minimum safety factor of 1.2 is recommended. We based these lateral resistance values on the assumption that the concrete for the foundations is either placed directly against undisturbed soils or that the voids created from the use of forms are backfilled with engineered fill or other approved materials, such as lean concrete. Passive resistance in the upper foot of soil cover below finished grades should be neglected unless the ground surface is confined by concrete slabs, pavements, or other such positive protection.

The following earth pressure parameters may be used for designing earth retaining structures and foundations.

Table 6: Lateral Earth Pressures

Lateral Pressure Conditions	Equivalent Fluid Pressure (pcf)
Active Pressure	70
At-Rest Pressure	90
Passive Pressure	225
Dynamic Increment	19.4H

Notes: 1. H is wall height in feet

Parameters are shown in the above table for drained conditions of select engineered fill or prepared native soil. In addition, the drained condition assumes that positive drainage will be provided away from the structure improvements and that water does not accumulate around the structure and cause a build-up of hydrostatic pressure.

4.9 Excavation Stability

Soils encountered within the upper 10-feet are generally Type C soil in accordance with OSHA (Occupational Safety and Health Administration). The slopes surrounding or along temporary excavations must be no steeper than 1.5H:1V to a maximum depth of 10-feet, and 2H:1V for excavations deeper than 10 feet, provided water is kept sufficiently out of the excavation by pumping or other dewatering

methods. It is anticipated that loose sands may be encountered as shallow as 10-feet below grade. Where sandy soils are encountered, slopes must be laid back flatter. Temporary excavations for the project construction must be left open for as short a time as possible and must be protected from water runoff. Slope height, slope inclination, and excavation depths (including utility trench excavations) must in no case exceed those specified in local, state, or federal safety regulations (e.g., OSHA Health and Safety Standards for Excavations 29 CFR Part 1926, or successor regulations). These excavation recommendations are based on soil characteristics derived from the borings. Variations in soil conditions will likely be encountered during excavation. At the time of construction, BSK must be afforded the opportunity to observe and document sloping and shoring conditions, and the opportunity to provide review of actual field conditions to account for condition variations not otherwise anticipated in the preparation of these recommendations.

4.10 Gasses Encountered

BSK did not encounter subterranean gasses during our investigation.

4.11 Temporary Shoring

Where there is insufficient space to layback slopes, temporary shoring will be necessary. Lateral earth pressures for cantilevered or braced shoring supporting level ground are presented in the following table.

Table 7: Lateral Earth Pressures for Temporary Shoring

Parameter	Pressure
Active Pressure	70 psf/ft
Braced Pressure	41.2H psf
Allowable Passive Pressure	
Solid Sheeting	135 psf/ft
Isolated Soldier Pile	340 psf/ft

Notes: [1] H is shored height in feet
[2] Values for isolated soldier piles already include an increase for arching, no further consideration should be applied.

In areas where the stability of adjoining improvements could be compromised by excavation operations, support systems such as shoring, bracing or underpinning may be required to provide stability and to protect personnel working within the excavation. Shoring, bracing, or underpinning required for the project (if any), should be designed by a professional engineer registered in the State of California.

4.12 Trench Backfill and Compaction

Processed on-site soils comprising silty sand and sand, which are free of organic material, are suitable for use as general trench backfill above the pipe envelope. The backfill must be placed in thin layers, not exceeding 12-inches in loose thickness, scarified (if necessary) to achieve a smooth and consistent texture, moisture conditioned to within one to three percent above optimum moisture content, and compacted to at least 90 percent of the maximum dry density as determined by ASTM: D1557. The uppermost 12-inches of trench backfill below pavement must be compacted to at least 95 percent of the maximum dry density as determined by ASTM: D1557 within proposed pavement areas, or as per Merced County or Caltrans Standards. Mechanical compaction methods are recommended, ponding or jetting should not be used. Moisture content within two percent of optimum moisture content must be maintained while compacting the upper 12-inch zone.

Field density testing must conform to ASTM Test Methods D1556, and/or D6938. We recommend that field density tests be performed in the utility trench bedding, envelope and backfill for every vertical lift, at an approximate longitudinal spacing of not greater than 250-feet. Backfill that does not conform to the criteria represented by the failing test must be removed or reworked as applicable over the trench length represented by the failing tests so as to conform to BSK recommendations.

4.13 Pipe Subgrade Preparation

Excavations to pipe subgrade elevation and setting of final grade is expected to produce soil disturbance, particularly in the sandier zones. In disturbed zones, six (6) inches below final subgrade elevation must be compacted to a minimum of 90 percent. Moisture conditions during compaction must be not less than optimum but not greater than 3 percent above optimum.

4.14 Pipe Bedding and Envelope

Pipes and conduits must be bedded and shaded in accordance with the requirements of the pipe manufacturer. Where no specific requirements exist, we recommend a minimum of 6-inches of sand bedding material for pipe installations 12 to 24-inches in diameter. For pipe diameters smaller than 12-inches, the bedding thickness may be reduced to 4-inches. Bedding material must consist of sand with not more than 5 percent passing the #200 Sieve and with 100 percent passing the 3/8-inch Sieve. We recommend that the pipe zone up to the spring line also be backfilled with the bedding materials described above.

The remaining pipe zone up to 12-inches above the top of the pipe must consist of friable granular backfill. Silty sand deposits with 35 percent or less passing the #200 sieve are suitable for backfill. Selective stockpiling may be necessary to isolate non-cemented friable soils.

Bedding and pipe zone backfill must be placed in loose thickness not exceeding 8-inches and compacted to not less than 90 percent of the maximum dry density as determined by ASTM Test Method D1557. Backfill moisture content during compaction must be maintained at 1 to 3 percent above optimum. Sand-cement slurry may be used for envelope backfill (50-200 psi at 28 days).

4.15 Modulus of Soil Reaction E´

Modulus of Soil Reaction E´ values for use in the Iowa Formula for estimating the deflection of buried flexible pipes are provided in Table 5. The materials include undisturbed native soils (trench sidewalls), compacted native soil backfill, Class 2 base rock conforming to Caltrans Section 26 of Standard Specifications and sand-cement slurry (50 psi at 7 days).

Table 8: Modulus of Subgrade Reaction (E´)

Material Designation	Modulus of Subgrade Reaction (E´), psi	Degree of Compaction of Bedding & Envelope (ASTM: D1557)
Trench Sidewalls: 0'-20' (SP/SM)	1050	-
Compacted Native Soil Backfill	1350	90 percent
Class 2 Base Rock:	3400	95 percent
Sand-Cement Slurry	4000	--

Note: * - Derived from standard penetration tests SM: Silty sand, SP: Sand

The Modulus of Subgrade Reaction is applicable to the determination of initial deflection only. For long-term deflection, a deflection lag factor of 1.25 is recommended for design purposes.

4.16 Horizontal Bearing Capacity-Thrust Blocks

We recommend that thrust blocks size determinations, in cases when force mains stabilization is required at pipe direction changes, be based on the following bearing values for shallow and deep thrust blocks. Shallow thrust blocks have a height greater than 70% of depth to center of pipeline. Deep thrust blocks have a height less than 70% of the depth to the pipe center.

Table 9: Horizontal Bearing Capacity

Loading	Thrust Block	Design Horizontal Bearing Capacity (psf)
Sustained	Shallow	225 psf/ft of depth
	Deep	400H psf

Test	Shallow Deep	300 psf/ft of depth 600H psf

Note: H is block height in feet

The thrust blocks must be cast between the pipe and undisturbed soil at the trench sidewalls. The horizontal deformation associated with the available capacity of shallow thrust blocks is 0.005D for test and sustained loading, where D is the depth to the bottom of the thrust block. It is anticipated the lateral movement associated with the available lateral bearing of deep thrust blocks under sustained or test loading is about 0.25 inch per 1000 psf of horizontal loading.

4.17 Pipe Loading Design Factors

Pipe loading design factors listed in Table below are provided for bedding material consisting of:

1) Native and imported sand or silty sand soil with less than 35 percent passing the #200 sieve and 100 percent passing the 3/8-inch sieve (SP/SM);
2) Class 2 crushed base rock conforming to Caltrans Section 26 of standard specifications;
3) Sand-cement slurry with 28-day compressive strength of 50-200 psi.

Table 10: Pipe Loading Design Factors

Materials Classification	Angle of Internal Friction, Degrees	Kμ (Marston's Formula)	Degree of Compaction ASTM: D1557
(1) ML/CL	18	0.17	90
(2) SM/SP	34	0.19	90
(3) Class 2 Aggregate Base	45	0.17	95
(4) Cement/Sand Slurry (CLSM)	55	0.14	--

A bulk unit weight of 130 pcf is recommended for compacted soil backfill within the pipe bedding and envelope. For Class 2 aggregate base, a unit weight of 140 pcf is recommended.

In the determination of the load coefficient, Kμ, "K" is Rankine's lateral earth pressure ratio and μ is equal to the coefficient of friction.

4.18 Trenchless Excavations

Three trenchless excavations ("jack and bore" operations) are planned for the proposed alignment, at the canal crossings. The soil conditions which will be encountered at the anticipated casing elevations are anticipated to be sandy silt and sandy clay to depths of approximately 16 feet bgs, underlain by silty sand,

clay, and poorly graded sand to depths of approximately 45 feet bgs, see Appendix A for detailed boring logs at the proposed crossings.

Soils caving may be present; therefore, a pipe extension may be required (e.g. sand plate or bonnet extension). Care should be taken to avoid advancement of the boring ahead of the casing.

4.19 Surface Drainage Control

Final grading around site improvements must provide for positive and enduring drainage. Ponding of water must not be allowed on or near the proposed structures. Saturation of the soils immediately adjacent to or below structures must not be allowed. Although landscaping is not anticipated, irrigation water must be applied in amounts not exceeding those required to offset evaporation, sustain plant life, and maintain a relatively uniform moisture profile around and below, site improvements. Fill elevations are anticipated to be less than 15 feet above natural grade to achieve positive site drainage.

5 PLANS AND SPECIFICATIONS REVIEW

BSK recommends that it be retained to review the draft plans and specifications for the project, with regard to foundations and earthwork, prior to there being finalized and issued for construction bidding.

6 CONSTRUCTION TESTING AND OBSERVATIONS

Geotechnical testing and observation during construction is a vital extension of this geotechnical investigation. BSK recommends that it be retained for those services. Field review during site preparation and grading allows for evaluation of the exposed soil conditions and confirmation or revision of the assumptions and extrapolations made in formulating the design parameters and recommendations. BSK's observations must be supplemented with periodic compaction tests to establish substantial conformance with these recommendations. BSK must also be called to the site to observe foundation excavations, prior to placement of reinforcing steel or concrete, in order to assess whether the actual bearing conditions are compatible with the conditions anticipated during the preparation of this report. BSK must also be called to the site to observe placement of foundation and slab concrete.

If a firm other than BSK is retained for these services during construction, that firm must notify the owner, project designers, governmental building officials, and BSK that the firm has assumed the responsibility for all phases (i.e., both design and construction) of the project within the purview of the geotechnical engineer. Notification must indicate that the firm has reviewed this report and any subsequent addenda, and that it either agrees with BSK's conclusions and recommendations, or that it will provide independent recommendations.

7 LIMITATIONS

The analyses and recommendations submitted in this report are based upon the data obtained from the test borings performed at the locations shown on Figure 2. The report does not reflect variations, which may occur between or beyond the borings. The nature and extent of such variations may not become evident until additional exploration and testing is performed, or construction is initiated. If variations then appear, a re-evaluation of the recommendations of this report will be necessary after performing on-site observations during the excavation period and noting the characteristics of the variations.

The validity of the recommendations contained in this report is also dependent upon an adequate testing and observation program during the construction phase. BSK assumes no responsibility for construction compliance with the design concepts or recommendations unless it has been retained to perform the testing and observation services during construction as described above.

The findings of this report are valid as of the present. However, changes in the conditions of the site can occur with the passage of time, whether caused by natural processes or the work of man, on this property or adjacent property. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation, governmental policy or the broadening of knowledge.

BSK has prepared this report for the exclusive use of the Client and members of the project design team. The report has been prepared in accordance with generally accepted geotechnical engineering practices, which existed in Merced County at the time the report was written. No other warranties either express or implied are made as to the professional advice provided under the terms of BSK's agreement with Client and included in this report.

FIGURES



SITE VICINITY MAP

FIGURE 1

Los Banos Santa Fe Grade Basin

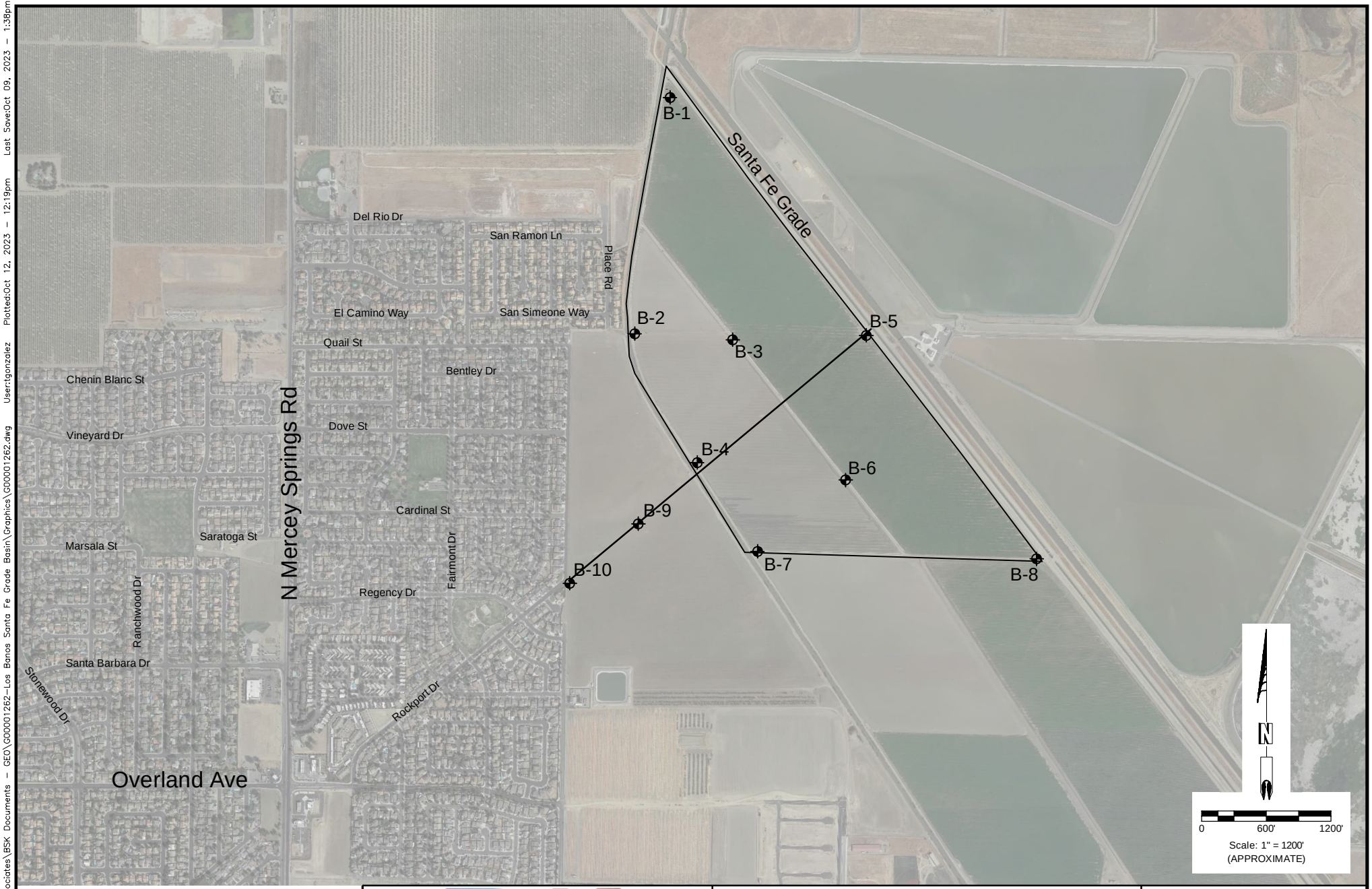
Los Banos, California

REFERENCE IMAGE: Google Earth

BSK ASSOCIATES
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Tel. (559) 497-2880

JOB NO. G00-001-262
DATE October 12, 2023
DR. BY TG
CH. BY NP
SCALE AS SHOWN
SHEET NO. 1
OF 1 SHEETS

C:\Users\tgonzalez\BSK Associates\BSK Documents - GEO\G000001262-Los Banos Santa Fe Grade Basin\Graphics\G000001262.dwg User:tgonzalez Plotted:Oct 12, 2023 - 12:20pm Last Save:Oct 09, 2023 - 1:38pm



LEGEND:

B-10 APPROXIMATE BORING LOCATIONS

REFERENCE IMAGE: Google Earth

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BORING LOCATION MAP

Los Banos Santa Fe Grade Basin

Los Banos, California

FIGURE 2

JOB NO. G00-001-262
DATE October 12, 2023
DR. BY TG
CH. BY NP
SCALE AS SHOWN
SHEET NO. 1
OF 1 SHEETS

C:\Users\tgonzalez\BSK Associates\BSK Documents - GEO\G00001262-Los Banos Santa Fe Grade Basin\Graphics\G00001262.dwg User:tgonzalez Plotted:Oct 12, 2023 - 12:19pm Last Save:Oct 09, 2023 - 1:38pm

APPENDIX A

FIELD EXPLORATION

APPENDIX A
Field Exploration

The field exploration, conducted on November 1 through November 3, 2023, consisted of a site reconnaissance and drilling ten (10) exploratory test boring to a maximum depth of approximately 16.5 to 51.5 feet below ground surface (bgs). The test borings were drilled with a truck-mounted drill rig, equipped with 8-inch augers. Details of the field exploration and the boring logs are provided in Appendix A.

The soil materials encountered in the test borings were visually classified in the field and logs were recorded during the excavation and sampling operations. Visual classification of the materials encountered in the test borings were made in general accordance with the Unified Soil Classification System (ASTM D2487). A soil classification chart is presented herein. Boring logs are presented herein and should be consulted for more details concerning subsurface conditions.

Subsurface samples were obtained at the various depths shown on the boring logs by driving samplers which consisted of a 2.5-inch inside diameter (I.D.) lined with stainless sleeves and 1.4-inch I.D. Standard Penetration Test (SPT) sampler. The samplers were driven 18 inches using a 140-pound, automatic hammer dropping 30 inches. The number of blows required to drive the last 12 inches was recorded as the blow count (blows/foot) on the log of borings. The relatively undisturbed soil core samples were capped at both ends to preserve the samples at their natural moisture content. Disturbed soil samples were obtained using the Split-Spoon Sampler (marked X in logs) and were placed and sealed in polyethylene bags. At the completion of the field exploration, the test borings were backfilled with the soil cuttings, as set forth in BSK's proposal.

It should be noted that the use of terms such as "soft", "medium stiff", "very stiff" or "hard" to describe the consistency of a soil is based on sampler blow count and is not necessarily reflective of the in-place density or unit weight of the soils being sampled. The relationship between sampler blow count and consistency is provided in the following Tables A-1 and A-2 for coarse grained (sandy and gravelly) soils and fine grained (silty and clayey) soils, respectively.

Table A-1: Density of Coarse-Grained Soil versus Sampler Blow Count		
Consistency	**SPT Blow Count Blows / Foot)**	**2.5" I.D. Cal. Sampler (Blows / Foot)**
Very Loose	<4	<6
Loose	4 – 10	6 – 15
Medium Dense	10 – 30	15 – 45
Dense	30 – 50	45 – 80
Very Dense	>50	>80

Table A-2: Consistency of Fine-Grained Soil versus Sampler Blow Count		
Consistency	**SPT Blow Count (Blows / Foot)**	**2.5" I.D. Cal. Sampler (Blows / Foot)**
Very Soft	<2	<3
Soft	2 – 4	3 – 6
Medium Stiff	4 – 8	6 – 12
Stiff	8 – 15	12 – 24
Very Stiff	15 – 30	24 – 45
Hard	>30	>45

MAJOR DIVISIONS				TYPICAL NAMES
COARSE GRAINED SOILS More than Half > #200 sieve	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	WELL GRADED GRAVELS, GRAVEL-SAND MIXTURES
			GP	POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES
		GRAVELS WITH OVER 15% FINES	GM	SILTY GRAVELS, POORLY GRADED GRAVEL-SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS, POORLY GRADED GRAVEL-SAND-CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	WELL GRADED SANDS, GRAVELLY SANDS
			SP	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 15% FINES	SM	SILTY SANDS, POOORLY GRADED SAND-SILT MIXTURES
			SC	CLAYEY SANDS, POORLY GRADED SAND-CLAY MIXTURES
FINE GRAINED SOILS More than Half < #200 sieve	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	PEAT AND OTHER HIGHLY ORGANIC SOILS

■	Modified California	RV	R-Value
⊠	Standard Penetration Test (SPT)	SA	Sieve Analysis
☒	Split Spoon	SW	Swell Test
◪	Pushed Shelby Tube	TC	Cyclic Triaxial
▯	Auger Cuttings	TX	Unconsolidated Undrained Triaxial
✋	Grab Sample	TV	Torvane Shear
⊘	Sample Attempt with No Recovery	UC	Unconfined Compression
CA	Chemical Analysis	(1.2)	(Shear Strength, ksf)
CN	Consolidation	WA	Wash Analysis
CP	Compaction	(20)	(with % Passing No. 200 Sieve)
DS	Direct Shear	▽	Water Level at Time of Drilling
PM	Permeability	▼	Water Level after Drilling(with date measured)
PP	Pocket Penetrometer		

SOIL CLASSIFICATION CHART AND LOG KEY

Figure A-1

BSK ASSOCIATES

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 1**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–5								CL	**Sandy CLAY** - brown, moist, fine to coarse grained sand	
6–9			68					SC	**Clayey SAND** - brown, moist, dense, fine to coarse grained sand	P.P. > 4.5 tsf
10–19			25	86.7	7.6			SP	**Poorly Graded SAND** - brown, wet, stiff, fine to coarse grained sand	
20–24			15	105.8	21.5			CL	**Sandy CLAY** - brown, wet, medium stiff, fine to coarse grained sand	▽ P.P. = 1.5 tsf
25–29			20							
30–34			11					SC	**Clayey SAND** - brown, wet, loose, fine to coarse grained sand	P.P. = 1.5 tsf

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/2/23
Date Completed: 11/2/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 51.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 1**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
36								CL	**Sandy CLAY** - brown, moist, stiff, fine to coarse grained sand *(continued)*	
37										
38										
39										
40										
41			23						... wet	P.P. = 1.75 tsf
42								SP	**Poorly Graded SAND** - gray, wet, fine to coarse grained sand	
43										
44										
45										
46			3							
47										
48										
49										
50										
51										
52										
53									Boring terminated at approximately 51.5 feet bgs. Groundwater encountered at 20 feet bgs. Boring backfilled with soil cuttings and grout.	
54										
55										
56										
57										
58										
59										
60										
61										
62										
63										
64										
65										
66										
67										
68										
69										

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/2/23
Date Completed: 11/2/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 51.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 2**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–4								CL	**Sandy CLAY** - yellow brown, moist, fine to medium grained sand	
5–6	■		30						... medium dense	
7–10										
11	■		18	95.7	27.0					
12–15										
15–16	■		14	98.7	26.9			SM	**Silty SAND** - brown, moist, medium-dense, fine grained sand	
17–34									Boring terminated at approximately 16.5 feet bgs. No groundwater encountered. Boring backfilled with soil cuttings and grout.	

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: Not Encountered
Completion Depth: 16.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 3**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–4								SC	**Clayey SAND** - brown, moist, fine to coarse grained sand, trace silt	
5	■							ML	**Sandy SILT** - brown, moist, hard, fine to coarse grained sand, trace clay	
6	■		52	103.8	22.7					
7–10										
11	■		60							
12–14								CL	**Sandy CLAY** - brown, moist, medium stiff, fine to coarse grained sand	
15	⧓									
16	⧓		9							
17–20										
21	■		17					SC	**Clayey SAND** - brown, moist, medium dense, fine to coarse grained sand	
22–23								SP	**Poorly Graded SAND** - brown, moist, fine to coarse grained sand	
24–25										
26	⧓		8					CL	**Sandy CLAY** - brown, moist, medium stiff, fine to coarse grained sand	
27–29										
30	■									▽
31	■		54						... increasing sand content	
32–34										

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 30 Feet
Completion Depth: 51.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 3**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
36	X		17						**Sandy CLAY** - brown, moist, medium stiff, fine to coarse grained sand *(continued)*	
37									... decreasing sand content	
38										
39										
40								SP	**Poorly Graded SAND** - brown, wet, loose, fine to coarse grained sand, trace clay	
41			10							
42										
43										
44										
45										
46	X		22						... without clay	
47										
48										
49										
50										No Recovery, flowing sands
51										
52									Boring terminated at approximately 51.5 feet bgs. Groundwater encountered at approximately 30 feet bgs. Boring backfilled with soil cuttings and grout.	
53										
54										
55										
56										
57										
58										
59										
60										
61										
62										
63										
64										
65										
66										
67										
68										
69										

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 30 Feet
Completion Depth: 51.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA
Project No.: G00-001-262
Logged By: J. Leu
Checked By: N. Popenoe

Boring: **B- 4**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–5								ML	**Sandy SILT** - yellow brown, moist, fine grained sand, trace clay	
6			13	101.3	17.2				... medium dense	
11			50/ 5"						... very dense	
16			15	100.7	21.1			SM	**Silty SAND** - brown, moist, medium dense, fine to medium grained sand	▽
21			19			11			... wet	
24								CL	**CLAY** - yellow brown, wet, medium dense, fine grained sand	
26			15	106.7	21.2					
31			32							PI = 12

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 45 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 4**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
36			26					SM	**Silty SAND** - brown, wet, medium dense, fine to coarse grained sand	
37–39										
40										
41			56						... very dense	
42–44										
45									Boring terminated at approximately 45 feet bgs due to flowing sands. Groundwater encountered at approximately 20 feet bgs. Boring backfilled with soil cuttings and grout.	flowing sands at 45 feet
46–69										

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 45 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Telephone: (559) 497-2880

Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 5**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–5								CL	**Sandy CLAY** - brown, moist, fine to coarse grained sand	
3				108.5	18.5					
6	■		41							P.P. > 4.5 tsf
10–11	■		15	94.8	27.0					P.P. = 1.5 tsf
15–16	■		20							P.P. = 2.25 tsf
20	▼									▽
21	⧓		8							
21									... increasing sand content	
22								SP	**Poorly Graded SAND** - brown, moist, fine to corase grained sand, trace clay	
24										flowing sands
25									Boring terminated at approximately 25 feet bgs. Groundwater encountered at approximately 20 feet bgs. Boring backfilled with soil cuttings and grout.	

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/2/23
Date Completed: 11/2/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 25 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 6**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–5								CL	**Sandy CLAY** - brown, moist, fine to medium grained sand	
6			50/ 5"						... very dense	
11			19	102.3	22.0				... yellow brown, medium dense	
14								SM	**Silty SAND** - brown, moist-wet, loose, fine to medium grained sand	
16			9							
20										▽
21			34	102.7	23.3	52				
25									Boring terminated at approximately 25 feet bgs. Groundwater encountered at approximately 20 feet bgs. Boring backfilled with soil cuttings and grout.	flowing sands

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/3/23
Date Completed: 11/3/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 25 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 7**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1								CL	**Sandy CLAY** - brown, moist, fine to medium grained sand	
2										
3									... yellow brown	
4										
5										
6			16	96.9	26.0				... brown, medium dense	
7										
8										
9										
10										
11			41						... yellow brown	
12										
13										
14								SM	**Silty SAND** - brown, moist, medium dense, fine to medium grained sand	
15										
16			19	94.2	21.6					
17										
18										
19										
20										▽
21			33					CL	**CLAY** - yellow brown, moist-wet, dense, fine grained sand	
22										
23										
24										
25										
26			9	91.9	31.2				... wet, loose	
27										
28										
29										
30										
31			14						... medium dense	
32										
33										
34										

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 51.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 7**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
36			16					SM	**Silty SAND** - brown, moist, medium dense, fine to medium grained sand	
37										
38										
39										
40										
41			27							
42										
43										
44								CL	**CLAY** - yellow brown, wet, medium dense, fine grained sand	
45										
46			18							
47										
48										
49										
50								SM	**Silty SAND** - brown, wet, medium dense, fine to medium grained sand	
51			12							
52									Boring terminated at approximately 51.5 feet bgs. Groundwater encountered at approximately 20 feet bgs. Boring backfilled with soil cuttings and grout.	
53										
54										
55										
56										
57										
58										
59										
60										
61										
62										
63										
64										
65										
66										
67										
68										
69										

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 51.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 8**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–5								ML	**Sandy SILT** - yellow brown,moist, fine to medium grained sand, trace clay	
6			50/ 4"						... very dense	
11			22	91.2	30.7				... medium dense, increase moisture content	
14								CL	**CLAY** - yellow brown, moist, medium dense, fine grained sand	
16			18							
21			46	107.0	21.9					▽
24								SM	**Silty SAND** - brown, wet, medium dense, fine to medium grained sand	
26			11							
29								CL	**CLAY** - yellow brown, wet, medium dense, fine grained sand	
31			24							
34										

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 40 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 8**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
36								SP	**Poorly Graded SAND** - gray, wet, very loose, fine to coarse grained sand	flowing sands
37										
38										
39										
40									Boring terminated at approximately 40 feet bgs. due to flowing sands Groundwater encountered at approximately 20 feet bgs. Boring backfilled with soil cuttings and grout.	
41										
42										
43										
44										
45										
46										
47										
48										
49										
50										
51										
52										
53										
54										
55										
56										
57										
58										
59										
60										
61										
62										
63										
64										
65										
66										
67										
68										
69										

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 20 Feet
Completion Depth: 40 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B- 9**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–4								CL	**CLAY** - yellow brown, moist, fine grained sand, trace fine to medium grained sand	
5–10	■		65					ML	**SILT** - yellow brown, moist, dense, fine grained sand, trace clay, trace fine to medium grained sand	
11–15	■		70							
16–19	■		48	103.2	12.5					
20–21	⧓		39					CL	**CLAY** - yellow brown, moist, dense, fine grained sand	
22–25										
26	■		33	101.0	24.1				Boring terminated at approximately 26.5 feet bgs. No groundwater encountered. Boring backfilled with soil cuttings and grout.	
27–34										

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: Not Encountered
Completion Depth: 26.5 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

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Project: Los Banos Santa Fe Grade Basin

Location: Los Banos, CA

Project No.: G00-001-262

Logged By: J. Leu

Checked By: N. Popenoe

Boring: **B-10**

Depth (Feet)	Samples	Bulk Samples	Penetration Blows / Foot	In-Situ Dry Density (pcf)	In-Situ Moisture Content (%)	% Passing No. 200 Sieve	Graphic Log	USCS	MATERIAL DESCRIPTION	REMARKS
1–5		✋						CL	**CLAY** - yellow brown, moist, medium dense, fine grained sand, trace fine to medium grained sand	
6	■		26			80				
7–10										
11	■		3	104.6	21.3					
12–15										
16	⧓		12							
17–20										
21	■		11	94.8	28.2					
22–25										
26	⧓		19					SM	**Silty SAND** - brown, wet, medium dense, fine to coarse grained sand	▽
27–34									Boring terminated at approximately 26.5 feet bgs. Groundwater encountered at approximately 26 feet bgs. Boring backfilled with soil cuttings and grout.	

Drilling Contractor: Baja Exploration
Drilling Method: Hollow Stem Auger
Drilling Equipment: CME75
Date Started: 11/1/23
Date Completed: 11/1/23

Surface Elevation:
Sample Method: 2.5" Modified Cal & 1.5" I.D. SPT Split Spoon
Groundwater Depth: 26 Feet
Completion Depth: 26 Feet
Borehole Diameter: 8"

* See key sheet for symbols and abbreviations used above.

APPENDIX B

LABORATORY TESTING

APPENDIX B
Laboratory Testing

The results of laboratory testing performed in conjunction with this project are contained in this Appendix. The following laboratory tests were performed on soil samples in general conformance with applicable standards.

In-Situ Moisture and Density

The field moisture content and in-place dry density determinations were performed on relatively undisturbed samples obtained from the test borings. The field moisture content, as a percentage of dry weight of the soils, was determined by weighing the samples before and after oven drying in accordance with ASTM D2216 test procedures. Dry densities, in pounds per cubic foot, were also determined for undisturbed core samples in accordance with ASTM D2937 test procedures. Test results are presented on the boring logs in Appendix A.

Double Hydrometer Test

Two (2) double hydrometer tests were performed on bulk samples in the area of planned construction at the site. The tests were performed in general accordance with Test Method ASTM D422. The results of the test are presented on Figure B-1 through Figure B-4.

Direct Shear Test

Two (2) direct shear tests were performed on test specimens trimmed from selected soil samples. The three-point shear test was performed in general accordance with ASTM D3080, Direct Shear Test for Soils under Consolidated Drained Conditions. The test specimens, each 2.42 inches in diameter and 1 inch in height, were subjected to shear along a plane at mid-height after allowing for pore pressure dissipation. The results of the tests are presented on Figures B-5 and B-6.

Collapse Potential Test

Two (2) Collapse Potential Tests were performed on relatively undisturbed soil samples to evaluate collapse potential characteristics. The tests were performed in general accordance with ASTM D5333. The sample was initially loaded under as-received moisture content to a selected stress level, loaded to a load of 2000 psf, saturated, and lastly loaded to a maximum load of 4000 psf. The test results are presented on Figure B-7 and B-8.

Expansion Index Test

One (1) Expansion Index Test was performed on a bulk soil sample in the Site area. The test was performed in general accordance with UBC Standard 18-2. The tests results are presented on Figure B-9.

Soil Corrosivity

The results of chemical analyses performed on a bulk soil sample using California Test Method 643 (for pH and minimum resistivity) and California Test Methods 417 and 422 (for soluble sulfate and chlorides, respectively), are presented below.

SUMMARY OF CHEMICAL TEST RESULTS

Sample Location	pH	Sulfate (ppm)	Chloride (ppm)	Minimum Resistivity (ohms-cm)
B-6 at 0-5´	9.1	390	180	460
B-9 at 20’-21.5’	8.6	270	120	750

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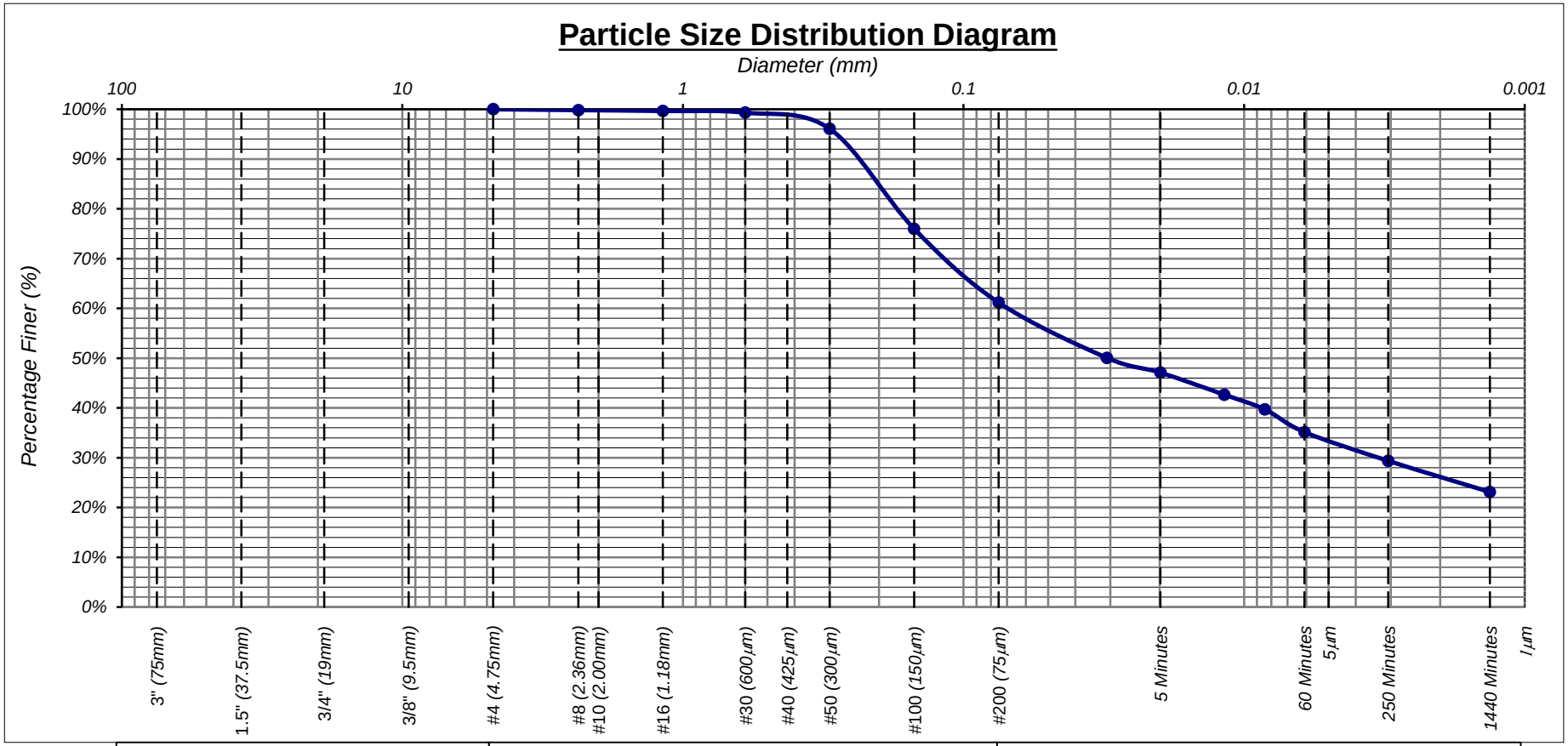
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FIGURE B-1

Gradation Analysis Report
ASTM D-422 / ASTM C-136

Project Name:	Los Banos	**Project Number:**	G00001262	**Report Date:**	11/28/23
Sample Location:	B - 1 @ 0 - 5'	**Sample Lab ID:**		**Sample Date:**	11/02/23
Sample Description:	Sandy Clay (CL) - brown, moist, fine to coarse grained sand			**Test Date:**	11/17/23

Particle Size Distribution Diagram



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel =	0%	% Sand =	39%	% Silt =	28%	% Clay =	33%

Reviewed By:_____

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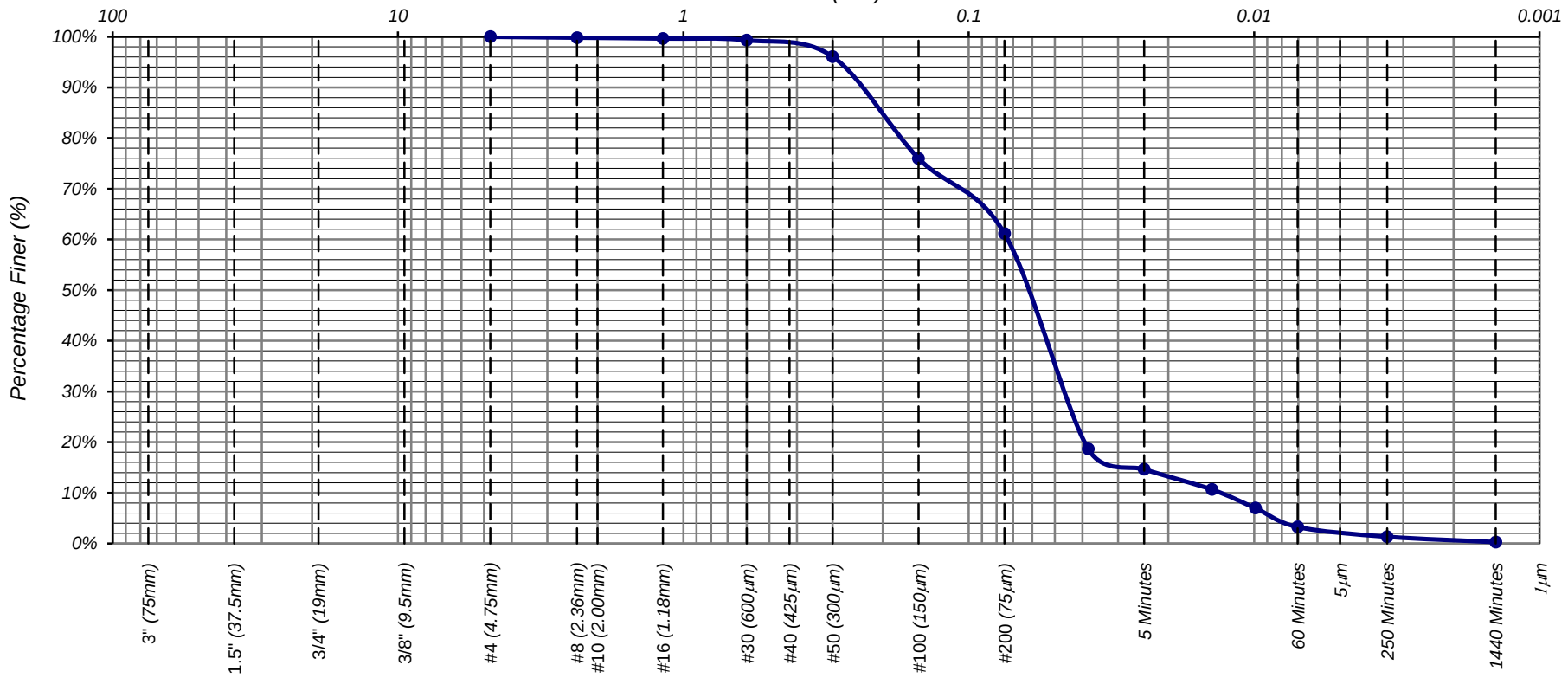
Gradation Analysis Report
ASTM D-422 / ASTM C-136

Double Hydrometer **FIGURE B-2**

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Project Name:	Los Banos	**Project Number:**	G00001262	**Report Date:**	11/28/23
Sample Location:	B - 1 @ 0 - 5'	**Sample Lab ID:**		**Sample Date:**	11/02/23
Sample Description:	Sandy Clay (CL) - brown, moist, fine to coarse grained sand - no deflocculant			**Test Date:**	11/17/23

Particle Size Distribution Diagram



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel =	0%	% Sand =	39%	% Silt =	59%	% Clay =	2%

Reviewed By:_____

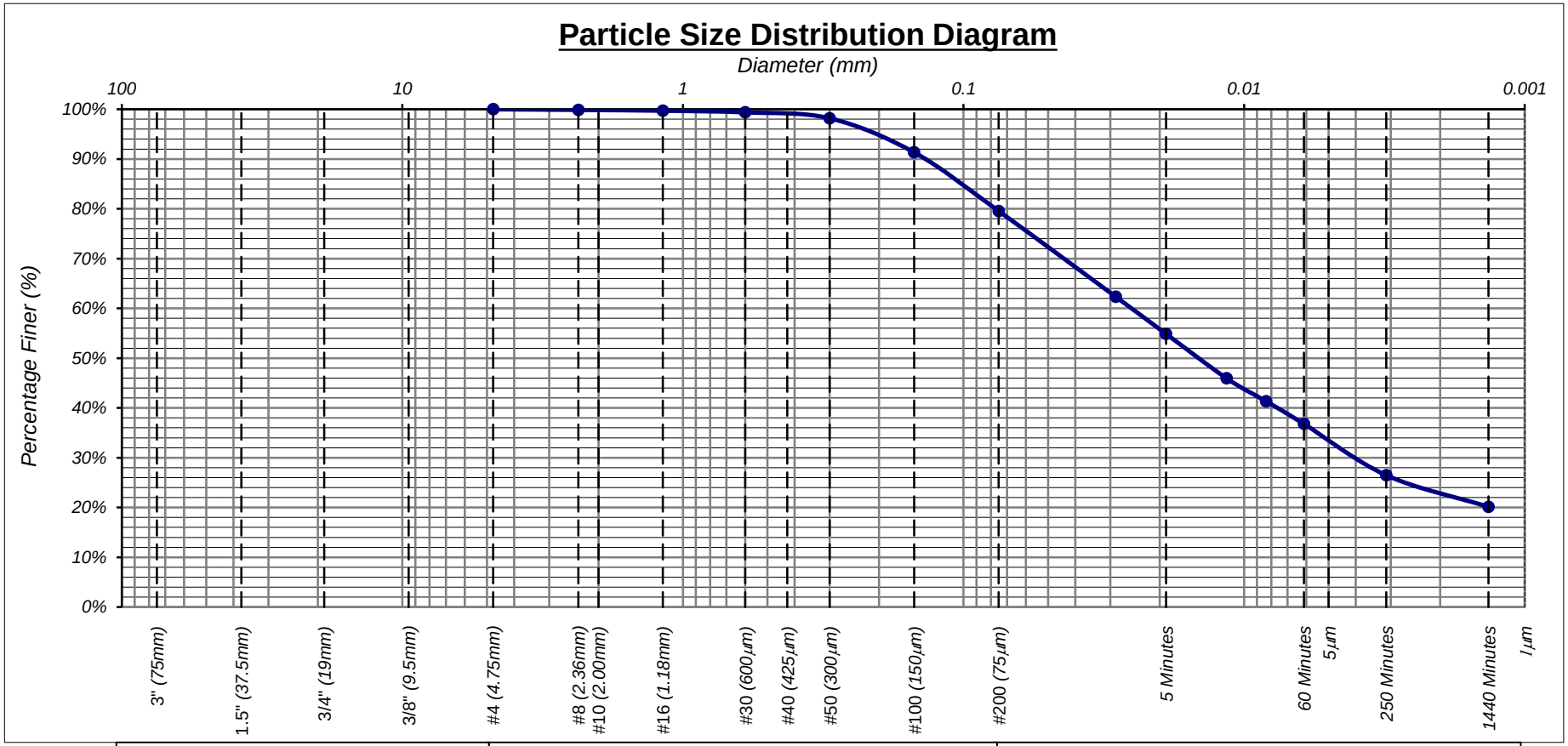
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FIGURE B-3

Gradation Analysis Report
ASTM D-422 / ASTM C-136

Project Name:	Los Banos Santa Fe Grade	**Project Number:**	G00001262	**Report Date:**	11/28/23
Sample Location:	B - 6 @ 0 - 5'	**Sample Lab ID:**		**Sample Date:**	11/03/23
Sample Description:	Sandy Clay (CL) - brown, moist, fine to medium grained sand			**Test Date:**	11/17/23

Particle Size Distribution Diagram



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel = 0% **% Sand = 20%** **% Silt = 47%** **% Clay = 33%**

Reviewed By:_____

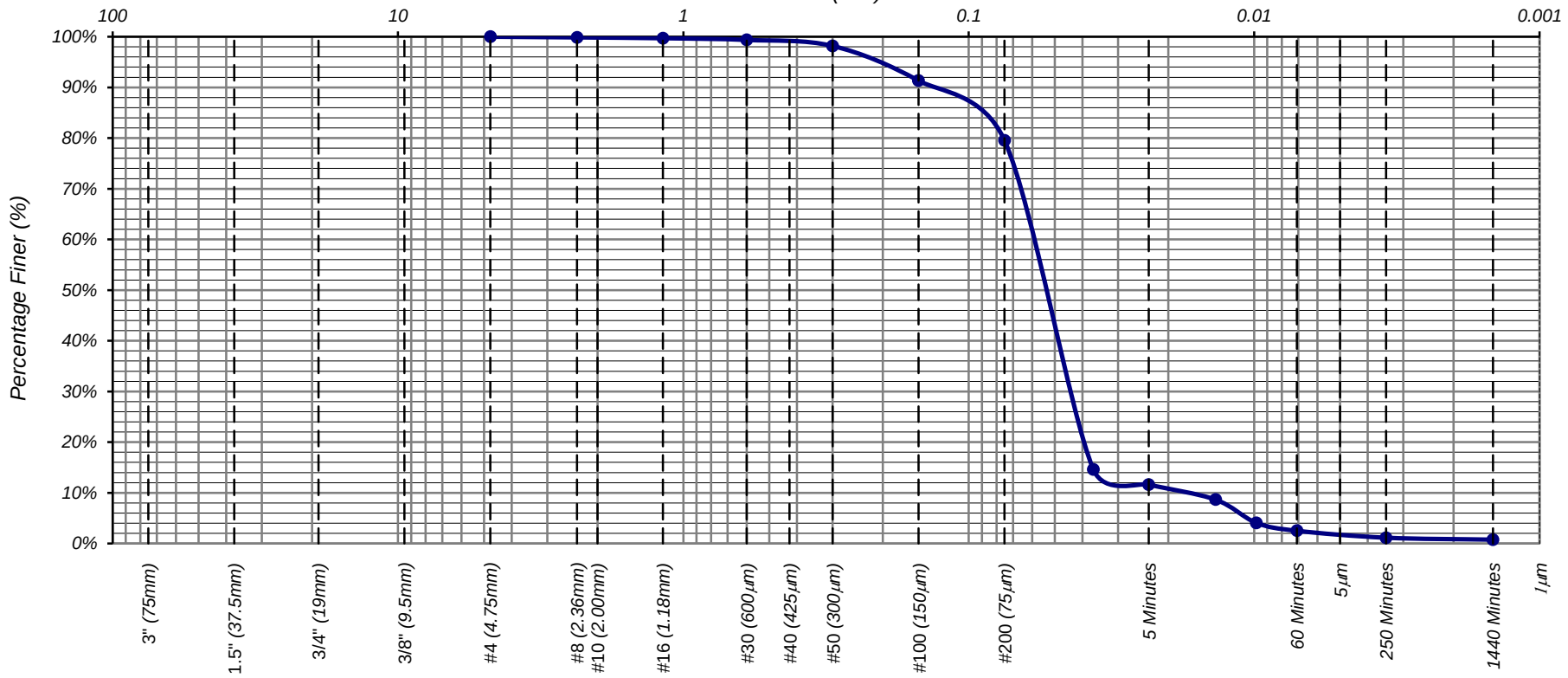
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Gradation Analysis Report
ASTM D-422 / ASTM C-136

Double Hydrometer **FIGURE B-4**

Project Name:	Los Banos Santa Fe Grade	**Project Number:**	G00001262	**Report Date:**	11/28/23
Sample Location:	B - 6 @ 0 - 5'	**Sample Lab ID:**		**Sample Date:**	11/03/23
Sample Description:	Sandy Clay (CL) - brown, moist, fine to medium grained sand - no deflocculant			**Test Date:**	11/17/23

Particle Size Distribution Diagram



Clear Square Openings (ASTM C-136)			US Standard Series (ASTM D-422)			Hydrometer Readings (ASTM D-422)
Cobble	Gravel		Sand			Silt (Non-Plastic) to Clay (Plastic)
	Coarse	Fine	Coarse	Medium	Fine	

% Gravel = 0% **% Sand = 20%** **% Silt = 78%** **% Clay = 2%**

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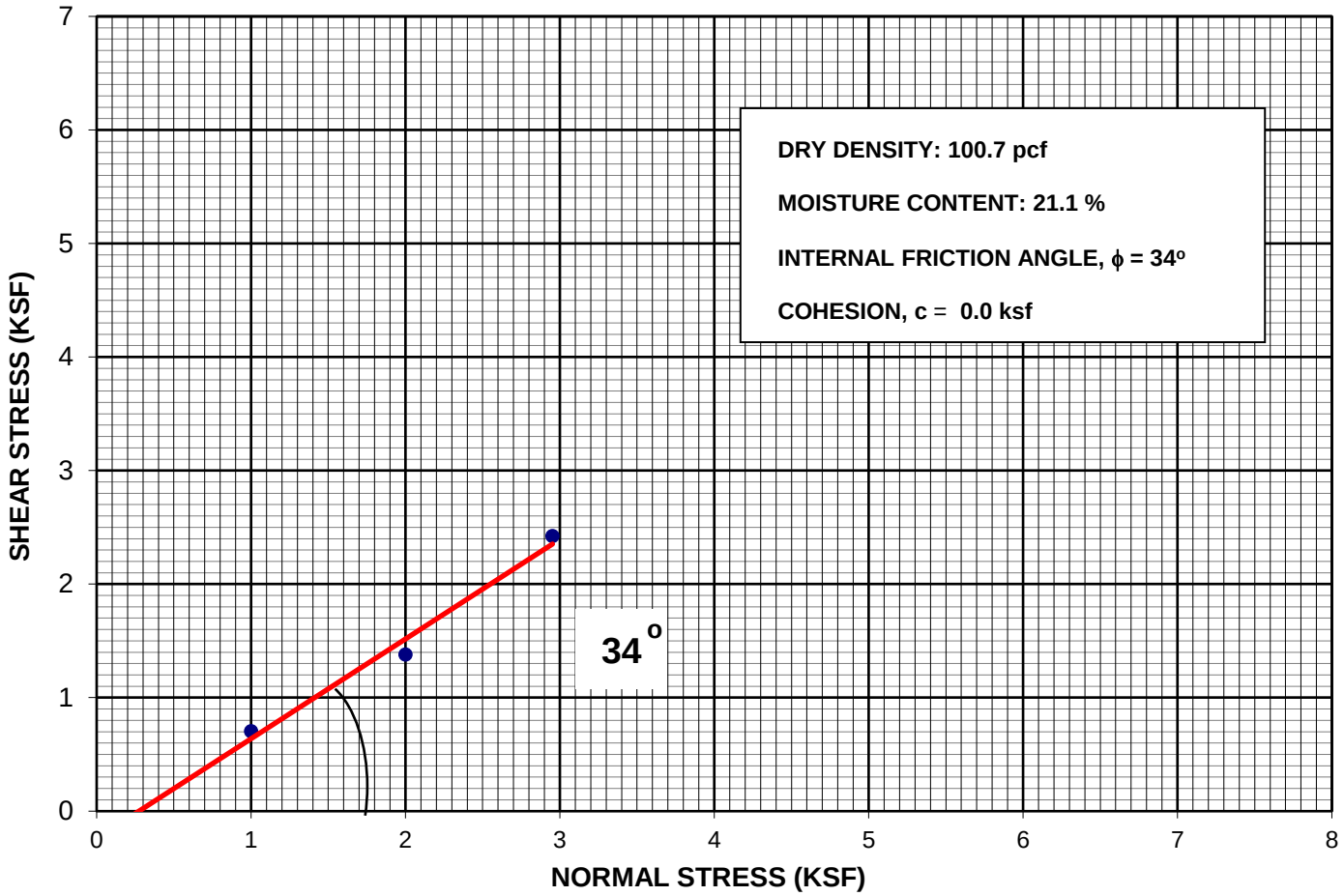
Direct Shear Test

ASTM D-3080

FIGURE B-5

Project Name:	Los Banos Basin	**Sampled By:**	T. Gorham	**Sample Date:**	11/1/23
		Tested By:	D. Messfin	**Test Date:**	11/13/23
Project Number:	G00001262	**Lab Tracking ID:**	N/A	**Report Date:**	11/27/23
Sample Location:	B-4 @ 16'	**Sample Description:**	Silty Sand - brown, moist, medium dense, fine to medium grained sand		

SHEAR STRENGTH DIAGRAM



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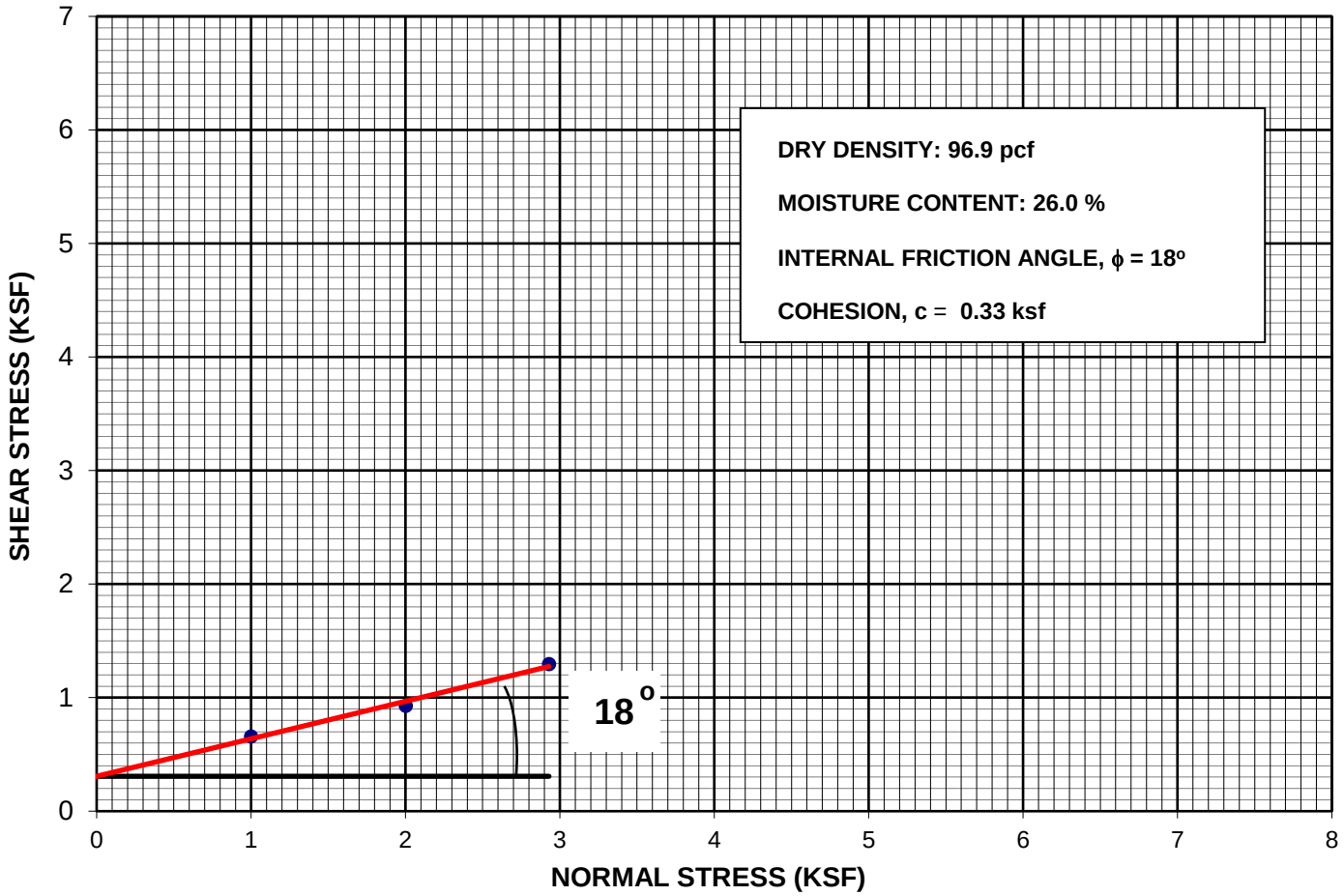
Direct Shear Test

ASTM D-3080

FIGURE B-6

Project Name:	Los Banos Basin	**Sampled By:**	T. Gorham	**Sample Date:**	11/1/23
		Tested By:	D. Messfin	**Test Date:**	11/13/23
Project Number:	G00001262	**Lab Tracking ID:**	N/A	**Report Date:**	11/27/23
Sample Location:	B-7 @ 6'	**Sample Description:**	Silty Clay - brown, moist, medium dense, fine to medium grained sand		

SHEAR STRENGTH DIAGRAM

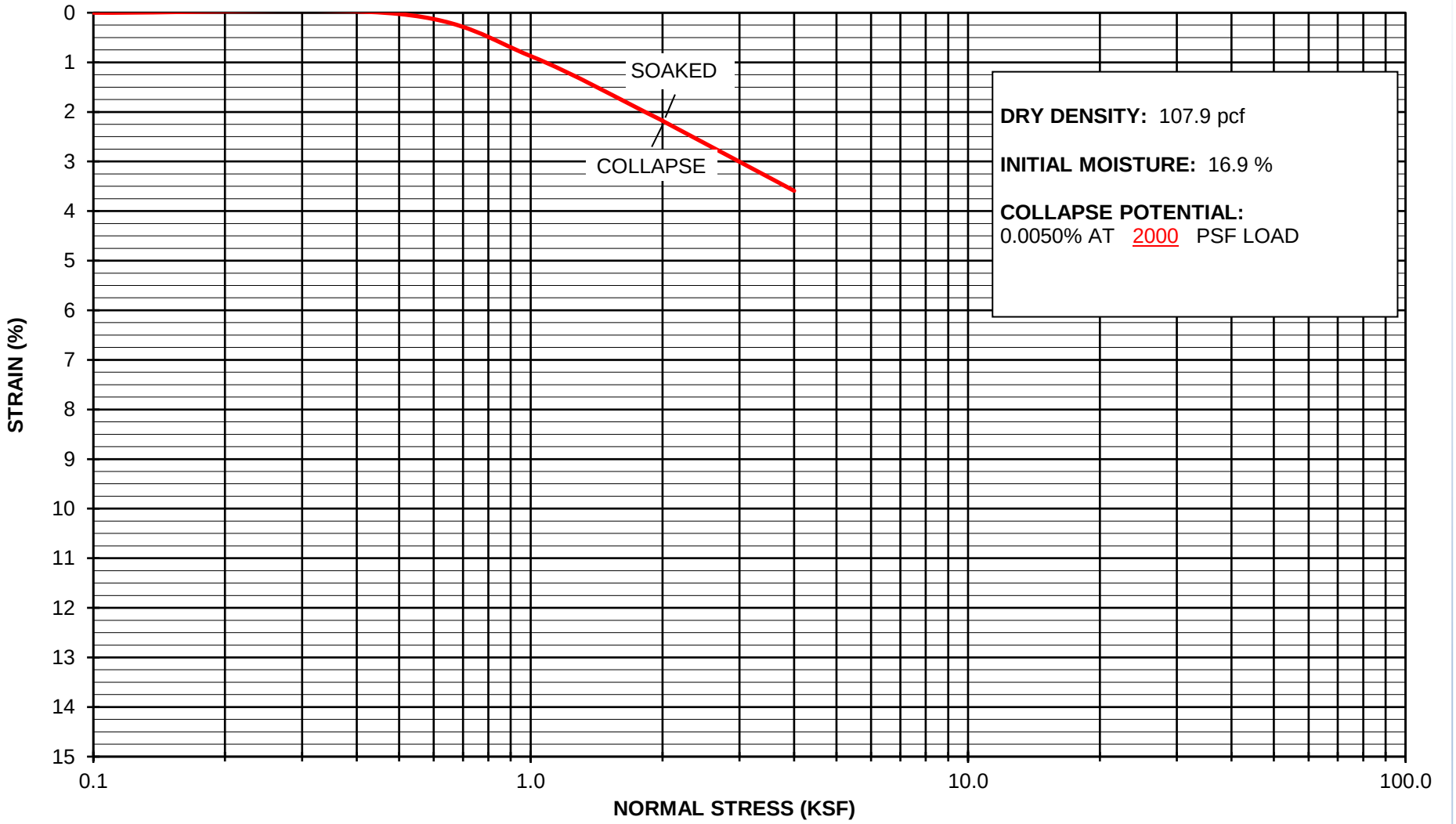


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COLLAPSE POTENTIAL
ASTM D-5333

FIGURE B-7

Project Name:	Los Banos Santa Fe Grade	**Sampled By:**	D.F	**Sample Date:**	11/1/23
		Tested By:	D.Messfin	**Test Date:**	11/13/23
Project Number:	G00001262	**Lab Tracking ID:**	N/A	**Report Date:**	11/17/23
Sample Location:	B-5 @ 11'	**Sample Description:**	Sandy Clay (CL) - brown, moist, fine to medium grained sand		

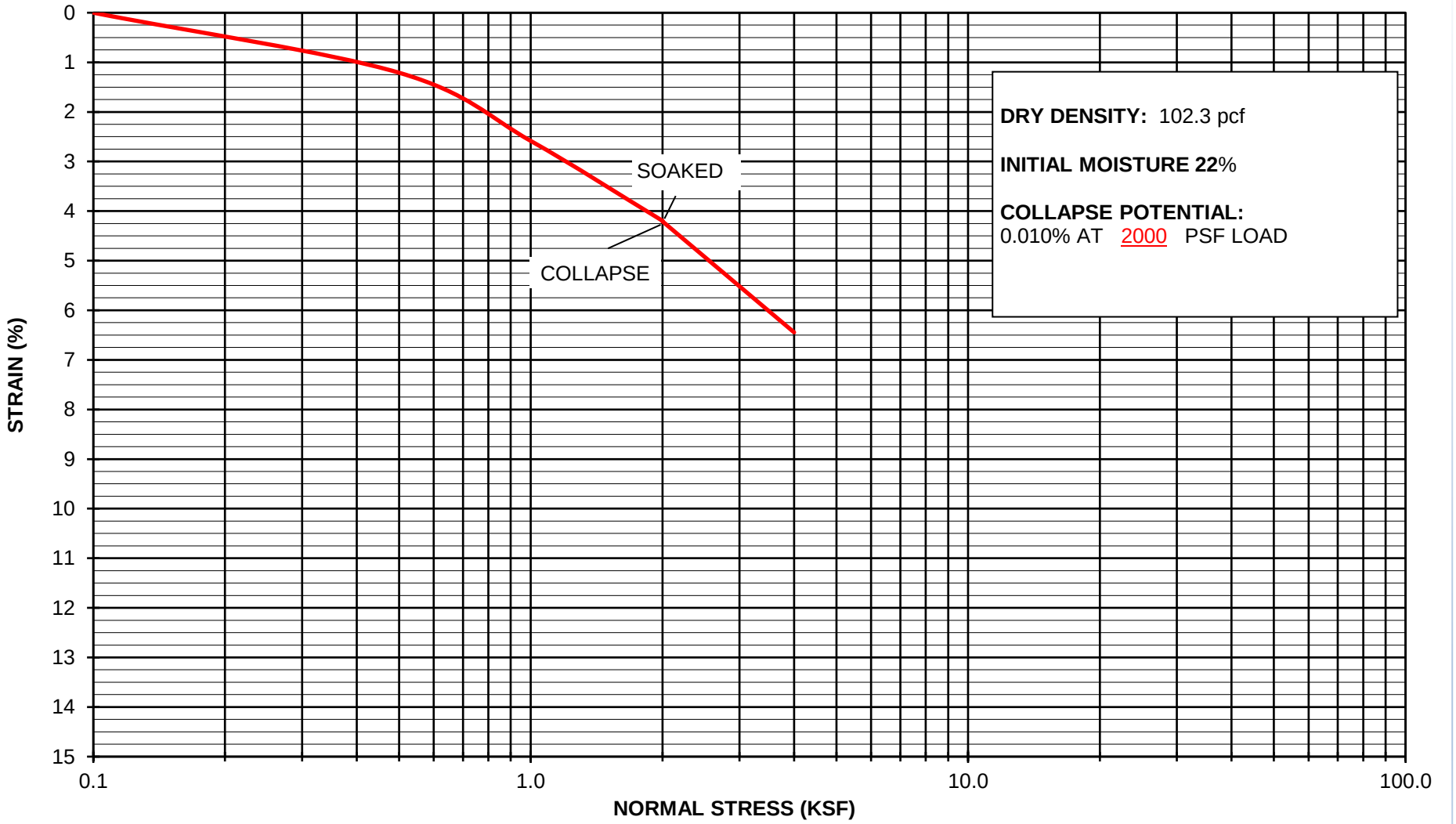


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Fresno, CA 93727
Ph: (559) 497-2880

FIGURE B-8

COLLAPSE POTENTIAL
ASTM D-5333

Project Name:	Los Banos Santa Fe Grade	**Sampled By:**	D.F	**Sample Date:**	11/3/23
		Tested By:	D.Messfin	**Test Date:**	11/13/23
Project Number:	G00001262	**Lab Tracking ID:**	N/A	**Report Date:**	11/17/23
Sample Location:	B-6 @ 11'	**Sample Description:**	Sandy Clay (CL) - yellow brown, moist, fine to medium grained sand, medium dense		



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550 W. Locust Avenue
Fresno, CA 93650
Ph: (559) 497-2868
Fax: (559) 485-6140

Expansion Index of Soils

ASTM D 4829 / UBC Standard 18-2

FIGURE B-9

Project Name:	Los Banos Santa	**Report Date:**	11/22/23
Project Number:	G00001262	**Sample Date:**	11/1-3/23
Lab Tracking ID:	N/A	**Test Date:**	11/21/23
Sample Location:	B - 6 @ 0 - 5'		
Sample Source	Bulk		
Sampled By:	J. Leu	**Tested By:** D.Messfin	**Reviewed By:** N. Popenoe

TEST DATA

INITIAL SET-UP DATA			
Sample + Tare Weight (g)	752.1		
Tare Weight (g)	367.3	**FINAL TAKE-DOWN DATA**	
		Moisture Content Data	
Wet Weight + Tare	149.8	Wet Weight + Tare	437.6
Dry Weight + Tare	136.72	Dry Weight + Tare	360.1
Tare Weight (g)	20.64	Tare Weight (g)	16.3
Moisture Content (%)	11.3%	Moisture Content (%)	22.5%
Initial Volume (ft^3)	0.007272	Final Volume (ft^3)	0.007425
Remolded Wet Density (pcf)	116.7	Final Wet Density (pcf)	125.8
Remolded Dry Density (pcf)	104.8	Final Dry Density (pcf)	102.7
Degree of Saturation	**50**	**Degree of Saturation**	**95**

EXPANSION READINGS

Initial Gauge Reading (in)	0.3313
Final Gauge Reading (in)	0.35235
Expansion (in)	0.02105

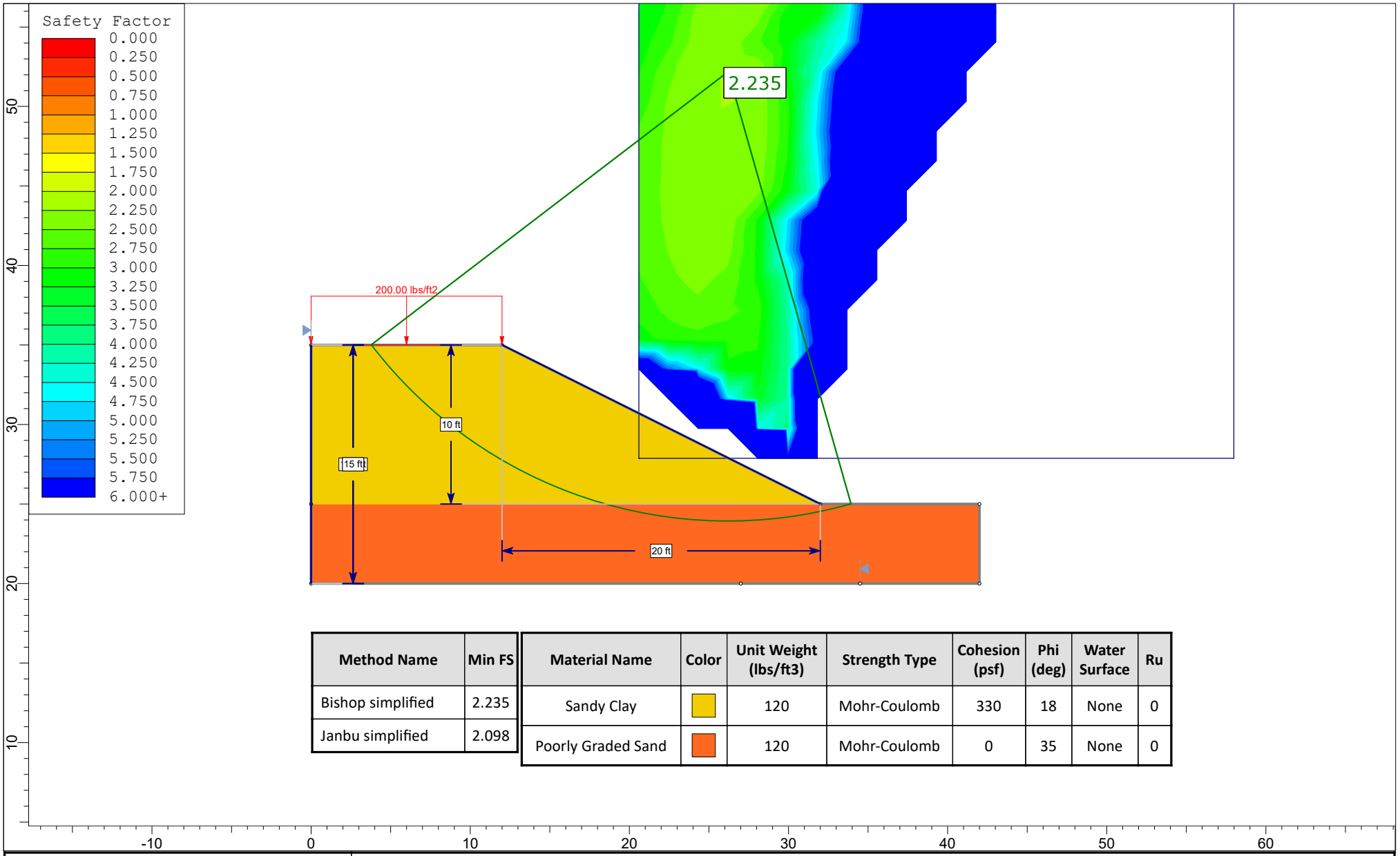
Uncorrected Expansion Index	**21**
Corrected Expansion Index, EI	**21**

Classification of Expansive Soil

EI	Potential Expansion
0 - 20	Very Low
21 - 50	Low
51 - 90	Medium
91 - 130	High
>130	Very High

APPENDIX C

SLOPE STABILITY



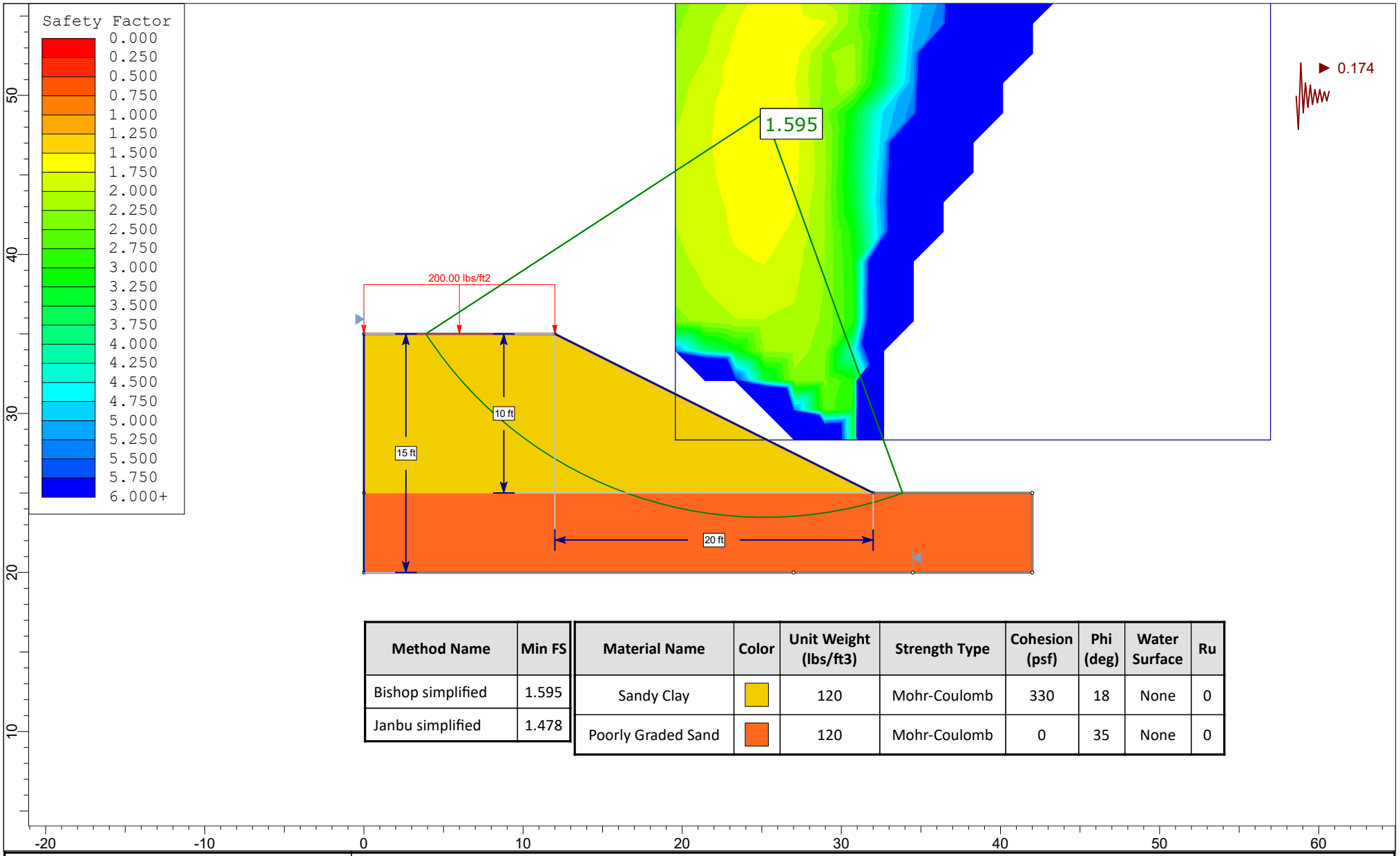
Method Name	Min FS
Bishop simplified	2.235
Janbu simplified	2.098

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Sandy Clay		120	Mohr-Coulomb	330	18	None	0
Poorly Graded Sand		120	Mohr-Coulomb	0	35	None	0

rocscience

SLIDEINTERPRET 7.038

Project	Los Banos Basin		
Analysis Description	2:1 Static		
Drawn By	T. Gorham	Scale 1:100	Company BSK Associates
Date	11/28/23		File Name G00001262.slmd



Method Name	Min FS
Bishop simplified	1.595
Janbu simplified	1.478

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)	Water Surface	Ru
Sandy Clay		120	Mohr-Coulomb	330	18	None	0
Poorly Graded Sand		120	Mohr-Coulomb	0	35	None	0

rocscience

SLIDEINTERPRET 7.038

Project	Los Banos Basin		
Analysis Description	2:1 Psuedo		
Drawn By	T. Gorham	Scale 1:100	Company BSK Associates
Date	11/28/23		File Name G00001262.slmd

APPENDIX D

WATER TESTING RESULTS

Case Narrative

Project and Report Details		Invoice Details	
Client:	BSK Associates - Fresno	**Invoice To:**	BSK Associates - Corporate
Report To:	Neva Popenoe	**Invoice Attn:**	BSK Associates-Corp
Project #:	G00001262	**Project PO#:**	-
Received:	11/01/2023 - 15:46		
Report Due:	11/20/2023		

Sample Receipt Conditions

Cooler: Default Cooler
Temperature on Receipt ºC: 1.0

Containers Intact
COC/Labels Agree
Received On Wet Ice
Sample(s) arrived at lab on same day sampled.
Packing Material - Other
Initial receipt at BSK-FAL

Data Qualifiers

The following qualifiers have been applied to one or more analytical results:

None applied

Report Distribution

Recipient(s)	Report Format	CC:
Neva Popenoe	FINAL.RPT	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Sample ID: AGK0204-01
Sampled By: Client
Sample Description: B8 @ 25'

Sample Date - Time: 11/01/2023 - 11:19
Matrix: Water
Sample Type: Grab

BSK Associates Laboratory Fresno

General Chemistry

Analyte	Method	Result	RL	Units	RL Mult	Batch	Prepared	Analyzed	Qual
Nitrate as N	EPA 300.0	**5.8**	1.2	mg/L	5	AGK0105	11/01/23 23:44	11/01/23	
Nitrate as NO3	EPA 300.0	**26**	5.0	mg/L	5	AGK0105	11/01/23 23:44	11/01/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Sample ID: AGK0204-01RE1
Sampled By: Client
Sample Description: B8 @ 25'

Sample Date - Time: 11/01/2023 - 11:19
Matrix: Water
Sample Type: Grab

BSK Associates Laboratory Fresno

General Chemistry

Analyte	Method	Result	RL	Units	RL Mult	Batch	Prepared	Analyzed	Qual
Hexavalent Chromium - Dissolved (1)	EPA 218.6	**19**	0.50	ug/L	10	AGK0984	11/15/23	11/15/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

BSK Associates Laboratory Fresno

General Chemistry Quality Control Report

Analyte	Result	RL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Date Analyzed	Qual
EPA 218.6 - Quality Control											
Batch: AGK0921										Prepared: 11/14/2023	
Prep Method: Method Specific Preparation										Analyst: CTD	
Blank (AGK0921-BLK1)											
Hexavalent Chromium - Dissolved (1)	ND	0.050	ug/L							11/14/23	
Blank Spike (AGK0921-BS1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	102	90-110			11/14/23	
Blank Spike Dup (AGK0921-BSD1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	101	90-110	1	10	11/14/23	
Matrix Spike (AGK0921-MS1), Source: AGK1519-01											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	99	90-110			11/14/23	
Matrix Spike Dup (AGK0921-MSD1), Source: AGK1519-01											
Hexavalent Chromium - Dissolved (1)	2.1	0.050	ug/L	2.0	ND	106	90-110	7	10	11/14/23	
EPA 218.6 - Quality Control											
Batch: AGK0984										Prepared: 11/15/2023	
Prep Method: Method Specific Preparation										Analyst: CTD	
Blank (AGK0984-BLK1)											
Hexavalent Chromium - Dissolved (1)	ND	0.050	ug/L							11/15/23	
Blank Spike (AGK0984-BS1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	101	90-110			11/15/23	
Blank Spike Dup (AGK0984-BSD1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	102	90-110	1	10	11/15/23	
Matrix Spike (AGK0984-MS1), Source: AGK0479-01RE1											
Hexavalent Chromium - Dissolved (1)	3.8	0.050	ug/L	2.0	1.9	95	90-110			11/15/23	
Matrix Spike Dup (AGK0984-MSD1), Source: AGK0479-01RE1											
Hexavalent Chromium - Dissolved (1)	3.9	0.050	ug/L	2.0	1.9	99	90-110	2	10	11/15/23	
EPA 300.0 - Quality Control											
Batch: AGK0105										Prepared: 11/1/2023	
Prep Method: Method Specific Preparation										Analyst: AAS	
Blank (AGK0105-BLK1)											
Nitrate as N	ND	0.23	mg/L							11/01/23	
Nitrate as NO3	ND	1.0	mg/L							11/01/23	
Blank Spike (AGK0105-BS1)											
Nitrate as N	23	0.23	mg/L	23	ND	100	90-110			11/01/23	
Nitrate as NO3	100	1.0	mg/L	100	ND	100	90-110			11/01/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

BSK Associates Laboratory Fresno

General Chemistry Quality Control Report

Analyte	Result	RL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Date Analyzed	Qual
EPA 300.0 - Quality Control											
Batch: AGK0105										Prepared: 11/1/2023	
Prep Method: Method Specific Preparation										Analyst: AAS	
Matrix Spike (AGK0105-MS1), Source: AGK0104-04											
Nitrate as N	17	0.23	mg/L	11	5.6	105	80-120			11/01/23	
Nitrate as NO3	77	1.0	mg/L	50	25	105	80-120			11/01/23	
Matrix Spike Dup (AGK0105-MSD1), Source: AGK0104-04											
Nitrate as N	17	0.23	mg/L	11	5.6	104	80-120	1	20	11/01/23	
Nitrate as NO3	77	1.0	mg/L	50	25	104	80-120	1	20	11/01/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Notes:

- The Chain of Custody document and Sample Integrity Sheet are part of the analytical report.
- Any remaining sample(s) for testing will be disposed of according to BSK's sample retention policy unless other arrangements are made in advance.
- All positive results for EPA Methods 504.1 and 524.2 require the analysis of a Field Reagent Blank (FRB) to confirm that the results are not a contamination error from field sampling steps. If Field Reagent Blanks were not submitted with the samples, this method requirement has not been performed.
- Samples collected by BSK Analytical Laboratories were collected in accordance with the BSK Sampling and Collection Standard Operating Procedures.
- J-value is equivalent to DNQ (Detected, not quantified) which is a trace value. A trace value is an analyte detected between the MDL and the laboratory reporting limit. This result is of an unknown data quality and is only qualitative (estimated). Baseline noise, calibration curve extrapolation below the lowest calibrator, method blank detections, and integration artifacts can all produce apparent DNQ values, which contribute to the un-reliability of these values.
- (1) - Residual chlorine and pH analysis have a 15 minute holding time for both drinking and waste water samples as defined by the EPA and 40 CFR 136. Waste water and ground water (monitoring well) samples must be field filtered to meet the 15 minute holding time for dissolved metals.
- Field tests are outside the scope of laboratory accreditation and there is no certification available for field testing.
- Summations of analytes (i.e. Total Trihalomethanes) may appear to add individual amounts incorrectly, due to rounding of analyte values occurring before or after the total value is calculated, as well as rounding of the total value.
- RL Multiplier is the factor used to adjust the reporting limit (RL) due to variations in sample preparation procedures and dilutions required for matrix interferences.
- Due to the subjective nature of the Threshold Odor Method, all characterizations of the detected odor are the opinion of the panel of analysts. The characterizations can be found in Standard Methods 2170B Figure 2170:1.
- The MCLs provided in this report (if applicable) represent the primary MCLs for that analyte.
- (2) - Formerly known as Bis(2-Chloroisopropyl) ether.

Unless otherwise noted, TOC results by SM 5310C method do not include purgeable organic carbon, which is removed along with the inorganic carbon interference. The POC contribution to TOC is considered to be negligible.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Definitions

mg/L:	Milligrams/Liter (ppm)	MDL:	Method Detection Limit	MDA95:	Min. Detected Activity
mg/Kg:	Milligrams/Kilogram (ppm)	RL:	Reporting Limit: DL x Dilution	MPN:	Most Probable Number
µg/L:	Micrograms/Liter (ppb)	ND:	None Detected below MRL/MDL	CFU:	Colony Forming Unit
µg/Kg:	Micrograms/Kilogram (ppb)	pCi/L:	PicoCuries per Liter	Absent:	Less than 1 CFU/100mLs
%:	Percent	RL Mult:	RL Multiplier	Present:	1 or more CFU/100mLs
NR:	Non-Reportable	MCL:	Maximum Contaminant Limit	U:	The analyte was not detected at or above the reported sample quantitation limit.

Please see the individual Subcontract Lab's report for applicable certifications.

The following parameters are not available for certification through CA ELAP:

Odor Diisopropyl ether (DIPE) by EPA 524.2

The following parameters are calculated values and are outside the scope of our NELAP accreditation:

Total Nitrogen Aggressive Index Trivalent Chromium

BSK is not accredited under the NELAP program for the following additional parameters: **NA**

Certifications: **Please refer to our website for a copy of our Accredited Fields of Testing under each certification.**

Fresno

State of California - ELAP	1180	State of Hawaii	4021
Los Angeles CSD	9254479	NELAP certified	4021-022
State of Nevada	CA000792024-03	State of Oregon - NELAP	4021-022
EPA UCMR5	CA00079	State of Washington	C997-23

Sacramento

State of California - ELAP	1180-S1		

San Bernardino

State of California - ELAP	1180-S2	Los Angeles CSD	9254478
NELAP certified	4119-008	State of Oregon - NELAP	4119-008

Vancouver

NELAP certified	WA100008-016	State of Oregon - NELAP	WA100008-016
State of Washington	C824-23		

Sample Integrity

BSK Bottles: Yes No Page 1 of 1

COC Info

Was temperature within range? Chemistry ≤ 6°C Micro < 8°C	Yes No NA	Were correct containers and preservatives received for the tests requested?	Yes No NA
If samples were taken today, is there evidence that chilling has begun?	Yes No NA	Bubbles Present VOAs (524.2/TTHM/TCP)? TB Received? (Check Method Below)	Yes No NA Yes No NA
Did all bottles arrive unbroken and intact?	Yes No	Was a sufficient amount of sample received?	Yes No
Did all bottle labels agree with COC?	Yes No	Do samples have a hold time <72 hours?	Yes No
Was sodium thiosulfate added to CN sample(s) until chlorine was no longer present?	Yes NA	Was PM notified of discrepancies? PM: By/Time:	Yes No NA

Bottles Received

"—" means preservation/chlorine checks are either N/A or are performed in the lab

250ml(A) 500ml(B) 1Liter(C) 40mlVOA(V) 125ml(D)	Checks*	Passed?					
Bacti $Na_2S_2O_3$	—	—					
None (P) White Cap	—	—	1C 1B				
Cr6 (P) Lt. Green Label/Blue Cap NH4OH(NH4)2SO4 **DW**	Cl, pH > 8	P F					
Cr6 (P) Pink Label/Blue Cap NH4OH(NH4)2SO4 **WW**	pH 9.3-9.7	P F	1A				
Cr6 (P) Black Label/Blue Cap NH4OH(NH4)2SO4 **7199** ***24 HOUR HOLD TIME***	pH 9.0-9.5	P F					
HNO_3 (P) Red Cap or HCl (P) Purple Cap/Lt. Blue Label	—	—					
H_2SO_4 (P) or (AG) Yellow Cap/Label	pH < 2	P F					
NaOH (P) Green Cap	Cl, pH >10	P F					
NaOH + ZnAc (P)	pH > 9	P F					
Dissolved Oxygen 300ml (g)	—	—					
None (AG) 608/8081/8082, 625, 632/8321, 8151, 8270	—	—					
HCl (AG) Lt. Blue Label O&G, Diesel, **TCP**	—	—					
Ascorbic, EDTA, KH_2Ct (AG) Pink Label 525	—	—					
Na_2SO_3 250mL (AG) Neon Green Label 515	—	—					
$Na_2S_2O_3$ 1 Liter (Brown P) 549	—	—					
$Na_2S_2O_3$ (AG) Blue Label 548, THM, 524	—	—					
$Na_2S_2O_3$ (CG) Blue Label 504, 505, 547	—	—					
$Na_2S_2O_3$ + MCAA (CG) Orange Label 531	pH < 3	P F					
NH_4Cl (AG) Purple Label 552	—	—					
EDA (P) or (AG) Brown Label DBPs	—	—					
HCL (CG) 524.2,BTEX,Gas, MTBE, 8260/624	—	—					
Buffer pH 4 (CG)	—	—					
H_3PO_4 (CG) Salmon Label	—	—					
Trizma – EPA 537.1 Light Blue Label **FB**	---	---					
Ammonia Acetate - EPA 533 Purple Label **FB**	---	---					
Bottled Water	—	—					
Asbestos 1L (P) w/ Foil / LL Metals Bottle	—	—					
Clear Glass	—	—					
OTHER:	—	—					

JV 11/1/23

Split

	Container	Preservative	Lot #	Initials	Date/Time
S P					
S P					

Preservation Check
pH Lot # AGO89910
Cl Lot #

Comments

*Preservation check completed by lab performing analysis.

✓ **Indicates Blanks Received**

504 ___ 524.2 ___ TTHM ___ 537/533 ___ TCP___

✓ **MS/MSD Received Method:** _____

Labeled by: **Labels Checked by:**

Scanned: ___ Rush/Short HT Page: _____ Time:_____

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BSK ASSOCIATES
687 N. Laverne Ave., Fresno, CA 93727
(559) 497-2888 CA ELAP No. 1180
www.bskassociates.com

Turnaround Time Request
- [x] Standard - 10 business days
- [ ] Rush (Surcharge may apply)
- Date needed:

AGK0204 BSKAs2880 11/01/2023 10

Temp: °C **Thermometer ID:** 1.0 ***Required Fields** 77

Company/Client Name*:	Report Attention*:	Invoice To*:	Phone*:	Fax:
BSK Associates - Fresno	Neva Popenoe Additional cc's:	BSK Associates - Corp PO#:	(559) 497-2880 E-mail*: npopenoe@bskassociates.com	

Address*:	City*:	State*:	Zip*:
691 N. Laverne Ave, Suite 101	Fresno	CA	93727

Project:	Project #:	Phase #	Task #:
Los Banos Santa Fe Grade Basin	G00001262		

Reporting Options: [ ] Trace (J-Flag) [ ] Swamp [ ] EDD Type: _____

Sampler Name (Printed/Signature)*:

Regulatory Carbon Copies: [ ] SWRCB (Drinking Water) [ ] Merced Co [ ] Fresno Co [ ] Madera Co [ ] Tulare Co [ ] Other: _____

Regulatory Compliance: [ ] EDT to California SWRCB (Drinking Water) System Number*: _____ [ ] Geotracker #: _____

Matrix Types: SW=Surface Water BW=Bottled Water GW=Ground Water WW=Waste Water STW=Storm Water DW=Drinking Water SO=Solid

#	Sample Description*	Sampled* Date	Sampled* Time	Matrix*	Comments / Station Code / WTRAX	Irrigation Water, Ag Suitability Dissolved	Dissolved: As, Se	Hex Chrom 218.6 Dissolved	SAR Pkg	Gypsum				
	B8@ 25'	11/1/23	1119	GW	Lab filter for dissolved metals	X	X	X	X	X				

Relinquished by: (Signature and Printed Name)	Company	Date	Time	Received by: (Signature and Printed Name)	Company
Jacob Lee		11/1/23	1546		
Relinquished by: (Signature and Printed Name)	Company	Date	Time	Received by: (Signature and Printed Name)	Company
Received for Lab by: (Signature and Printed Name)		Date	Time	Payment Received at Delivery: Date: Amount: PIA#: Check / Cash Init.	
Shirley Lee		11/1/23	1546		

Shipping Method: GLS UPS WALK-IN FED EX PMS Courier: _____ **Custody Seal:** Y / N

Cooling Method: Wet Blue None **Chilling Process Begun:** Y / N

Payment for services rendered as noted herein are due in full within 30 days from the date invoiced. If not so paid, account balances are deemed delinquent. Delinquent balances are subject to monthly service charges and interest specified in BSK's current Standard Terms and Conditions for Laboratory Services. The person signing for the Client/Company acknowledges that they are either the Client or an authorized agent to the Client, that the Client agrees to be responsible for payment for the services on this Chain of Custody, and agrees to BSK's terms and conditions for laboratory services unless contractually bound otherwise. BSK's current terms and conditions can be found at www.bskassociates.com/BSKLabTermsConditions.pdf

November 13, 2023

Lab No. : SP 2318471
Customer No. : 2022939

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Laboratory Report

Introduction: This report package contains a total of 6 pages divided into 3 sections:

Case Narrative	(2 pages)	: An overview of the work performed at FGL.
Sample Results	(1 page)	: Results for each sample submitted.
Quality Control	(3 pages)	: Supporting Quality Control (QC) results.

Case Narrative

This Case Narrative pertains to the following samples:

Sample Description	Date Sampled	Date Received	FGL Lab No.	Matrix
B8 @ 25	11/01/2023	11/03/2023	SP 2318471-001	W

Sampling and Receipt Information:

The Sample was received in acceptable condition and within temperature requirements, unless noted on the Condition Upon Receipt (CUR) form. The Sample was received, prepared and analyzed within the method specified holding times except those as listed in the table below. All samples arrived at 6 ° C. All samples were checked for pH if acid or base preservation is required (except for VOAs). For details of sample receipt information, please see the associated Chain of Custody and Condition Upon Receipt Form.

Samples Over Hold Time

Lab No	Analyte Method	Maximum Hold Time	Actual Hold Time
SP 2318471-001	Nitrate	48 hours	122.2 hours
SP 2318471-001	Nitrate Nitrogen	48 hours	122.2 hours
SP 2318471-001	pH	15 minutes	7,517.0 minutes
SP 2318471-001	Total Dissolved Solids (TFR)	7 days	8.0 days

Quality Control: All samples were prepared and analyzed according to established quality control criteria. Any exceptions are noted in the Quality Control Section of this report.

Test Summary	
EPA 200.7	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
EPA 200.8	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
EPA 300.0	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
SM 2540 C	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
SM 4500-H+B	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)

Corporate Offices & Laboratory
853 Corporation Street
Santa Paula, CA 93060
TEL: (805)392-2000
Env FAX: (805)525-4172 / Ag FAX: (805)392-2063
CA ELAP Certification No. 1573

Office & Laboratory
2500 Stagecoach Road
Stockton, CA 95215
TEL: (209)942-0182
FAX: (209)942-0423
CA ELAP Certification No. 1563

Office & Laboratory
563 E. Lindo Avenue
Chico, CA 95926
TEL: (530)343-5818
FAX: (530)343-3807
CA ELAP Certification No. 2670

Office & Laboratory
3442 Empresa Drive, Suite D
San Luis Obispo, CA 93401
TEL: (805)783-2940
FAX: (805)783-2912
CA ELAP Certification No. 2775

Office & Laboratory
9415 W. Goshen Avenue
Visalia, CA 93291
TEL: (559)734-9473
FAX: (559)734-8435
CA ELAP Certification No. 2810

Certification: I certify that this data package is in compliance with ELAP standards, both technically and for completeness, except for any conditions listed above and in the QC Section. Release of the data contained in this data package is authorized by the Laboratory Director or his designee, as verified by the following electronic signature. This report shall not be reproduced except in full, without the written approval of the laboratory.

KD: MKH

Approved By **Kelly A. Dunnahoo, B.S.** Digitally signed by Kelly A. Dunnahoo, B.S.
Title: Laboratory Director
Date: 2023-11-13

Page 2 of 6

November 13, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B8 @ 25
Project : AGK0204

Lab No. : SP 2318471-001
Customer No. : 2022939

Sampled On : November 1, 2023 at 11:19
Sampled By : Client
Received On : November 3, 2023 at 11:00
Matrix : Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
Irrigation Suit							Date	Time	Who	Method	Date	Time	Who
Total Hardness as CaCO3	774	2.5	mg/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:23	ac
Calcium	142	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:23	ac
Magnesium	102	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:23	ac
Potassium	10	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:23	ac
Sodium	523	5*	mg/L		5		11/06/2023	09:00	ac	EPA 200.7	11/08/2023	12:25	ac
Total Cations	38.5	---	meq/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:23	ac
Boron	3.2	0.1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:23	ac
Copper	ND	10	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:23	ac
Iron	ND	30	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:23	ac
Manganese	20	10	ug/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:23	ac
Zinc	ND	20	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:23	ac
Gypsum Requirement	0.9	0.01	Tons/AF		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:23	ac
SAR	8.2	0.1	--		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:23	ac
Total Alkalinity	40	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:30	amm
Hydroxide	10	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:30	amm
Carbonate	10	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:30	amm
Bicarbonate	30	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:30	amm
Sulfate	941	6*	mg/L		10		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	09:00	ldm
Chloride	570	12*	mg/L		10		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	09:00	ldm
Nitrate	34.0	0.4	mg/L		1	T	11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	03:24	ldm
Nitrate Nitrogen	7.7	0.1	mg/L		1	T	11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	03:24	ldm
Fluoride	0.2	0.1	mg/L		1		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	03:24	ldm
Total Anions	37.6	---	meq/L		1		11/06/2023	16:36	amm	Calc.	11/06/2023	20:30	amm
pH	8.84	---	units		1	T	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:30	amm
E. C.	3610	1	umhos/cm		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:30	amm
TDS by Summation	2370	0	mg/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:23	ac
Metals, Diss													
Arsenic	9	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/10/2023	14:01	ac
Selenium	9	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/09/2023	11:40	ac
Wet Chemistry													
Total Dissolved Solids (TFR)	2600	20	mg/L		1	T	11/09/2023	11:45	ctl	SM 2540 C	11/10/2023	11:00	ctl

DQF Flags Definition:
U Constituent results were non-detect.
T Exceeded method/regulatory-specific holding time.
h The MS/MSD did not meet QC criteria.

ND=Non-Detected, RL=Reporting Level * RL adjusted for dilution, Dil.=Dilution

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November 13, 2023
BSK Associates

Lab No. : SP 2318471
Customer No. : 2022939

Quality Control - Metals

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Metals								
Boron	200.7	11/06/2023:212572AC	MS	mg/L	4.000	91.9%	75-125	
		(SP 2318527-006)	MSD	mg/L	4.000	98.6%	75-125	
			MSRPD	mg/L		6.1%	≤20.0	
Calcium	200.7	11/06/2023:212572AC	MS	mg/L	12.00	46.9%	<¼	406
		(SP 2318527-006)	MSD	mg/L	12.00	69.8%	<1/4	
			MSRPD	mg/L		2.1%	≤20.0	
Copper	200.7	11/06/2023:212572AC	MS	ug/L	800.0	93.9%	75-125	
		(SP 2318527-006)	MSD	ug/L	800.0	101%	75-125	
			MSRPD	ug/L		7.6%	≤20.0	
Iron	200.7	11/06/2023:212572AC	MS	ug/L	4000	83.2%	75-125	
		(SP 2318527-006)	MSD	ug/L	4000	92.8%	75-125	
			MSRPD	ug/L		10.9%	≤20.0	
Magnesium	200.7	11/06/2023:212572AC	MS	mg/L	12.00	76.7%	75-125	
		(SP 2318527-006)	MSD	mg/L	12.00	87.7%	75-125	
			MSRPD	mg/L		2.7%	≤20.0	
Manganese	200.7	11/06/2023:212572AC	MS	ug/L	800.0	95.5%	75-125	
		(SP 2318527-006)	MSD	ug/L	800.0	103%	75-125	
			MSRPD	ug/L		5.9%	≤20.0	
Potassium	200.7	11/06/2023:212572AC	MS	mg/L	12.00	91.1%	75-125	
		(SP 2318527-006)	MSD	mg/L	12.00	99.2%	75-125	
			MSRPD	mg/L		5.6%	≤20.0	
Sodium	200.7	11/06/2023:212572AC	MS	mg/L	12.00	55.4%	<¼	406
		(SP 2318527-006)	MSD	mg/L	12.00	77.2%	75-125	
			MSRPD	mg/L		2.6%	≤20.0	
Zinc	200.7	11/06/2023:212572AC	MS	ug/L	800.0	87.9%	75-125	
		(SP 2318527-006)	MSD	ug/L	800.0	92.5%	75-125	
			MSRPD	ug/L		4.9%	≤20.0	
Arsenic	200.8	11/09/2023:212732AC	MS	ug/L	5.000	553%	75-125	435
		(CH 2379204-001)	MSD	ug/L	5.000	638%	75-125	435
			MSRPD	ug/L		14.2%	≤20	
Selenium	200.8	11/09/2023:212732AC	MS	ug/L	5.000	578%	75-125	435
		(CH 2379204-001)	MSD	ug/L	5.000	603%	75-125	435
			MSRPD	ug/L		4.2%	≤20	

Definition

DQO : Data Quality Objective - This is the criteria against which the quality control data is compared.

MS : Matrix Spikes - A random sample is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.

MSD : Matrix Spike Duplicate of MS/MSD pair - A random sample duplicate is spiked with a known amount of analyted. The recoveries are an indication of how that sample matrix affects analyte recovery.

MSRPD : MS/MSD Relative Percent Difference (RPD) - The MS relative percent difference is an indication of precision for the preparation and analysis.

ND : Non-detect - Result was below the DQO listed for the analyte.

Explanation

406 : Matrix Spike (MS) not within the Acceptance Range (AR) because of high analyte concentration in the sample. Data was accepted based on the LCS or CCV recovery.

435 : Sample matrix may be affecting this analyte. Data was accepted based on the LCS or CCV recovery.

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November 13, 2023
BSK Associates

Lab No. : SP 2318471
Customer No. : 2022939

Quality Control - Wet Chem

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Wet Chem								
Alkalinity (as CaCO3)	2320B	11/06/2023:212619AMM	ND	mg/L		1.25%	10	435
Bicarbonate	2320B	(SP 2318491-001)	Dup	mg/L		1.25%	10	
E. C.	2320B	(SP 2318491-001)	Dup	umhos/cm		0.2%	5	
pH	2320B	(SP 2318491-001)	Dup	units		1.11%	4.80	
Solids, Total Dissolved	2540CE	11/09/2023:212748CTL	Blank	mg/L		ND	<20	
			LCS	mg/L	991.5	101%	90-110	
		(SP 2318698-001)	Dup	mg/L		0.2%	5	
		(SP 2318698-001)	Dup	mg/L		1.16%	5	
Chloride	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<1	
			LCS	mg/L	25.00	102%	90-110	
			MS	mg/L	50.00	102%	67-117	
		(CH 2379032-008)	MSD	mg/L	50.00	102%	67-117	
			MSRPD	mg/L		0.0%	≤7	
			MS	mg/L	50.00	103%	67-117	
		(STK2354964-004)	MSD	mg/L	50.00	103%	67-117	
			MSRPD	mg/L		0.2%	≤7	
Fluoride	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<0.1	
			LCS	mg/L	2.500	102%	90-110	
			MS	mg/L	5.000	99.6%	89-111	
		(CH 2379032-008)	MSD	mg/L	5.000	97.2%	89-111	
			MSRPD	mg/L		1.7%	≤9	
			MS	mg/L	5.000	103%	89-111	
		(STK2354964-004)	MSD	mg/L	5.000	101%	89-111	
			MSRPD	mg/L		1.7%	≤9	
Nitrate	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<0.4	
			LCS	mg/L	20.00	100%	90-110	
			MS	mg/L	40.00	103%	86-112	
		(CH 2379032-008)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.0%	≤7	
			MS	mg/L	40.00	103%	86-112	
		(STK2354964-004)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.0%	≤7	
Nitrate Nitrogen	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<0.4	
			LCS	mg/L	20.00	100%	90-110	
			MS	mg/L	40.00	103%	86-112	
		(CH 2379032-008)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.0%	≤7	
			MS	mg/L	40.00	103%	86-112	
		(STK2354964-004)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.0%	≤7	
Sulfate	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<0.5	
			LCS	mg/L	50.00	103%	90-110	
			MS	mg/L	100.0	102%	18-165	
		(CH 2379032-008)	MSD	mg/L	100.0	103%	18-165	
			MSRPD	mg/L		0.1%	≤7	
			MS	mg/L	100.0	104%	18-165	
		(STK2354964-004)	MSD	mg/L	100.0	104%	18-165	
			MSRPD	mg/L		0.3%	≤7	

Page 5 of 6

Definition

Blank	:	Method Blank - Prepared to verify that the preparation process is not contributing contamination to the samples.
Dup	:	Duplicate Sample - A random sample with each batch is prepared and analyzed in duplicate. The relative percent difference is an indication of precision for the preparation and analysis.
LCS	:	Laboratory Control Standard/Sample - Prepared to verify that the preparation process is not affecting analyte recovery.
MS	:	Matrix Spikes - A random sample is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.
MSD	:	Matrix Spike Duplicate of MS/MSD pair - A random sample duplicate is spiked with a known amount of analyted. The recoveries are an indication of how that sample matrix affects analyte recovery.
MSRPD	:	MS/MSD Relative Percent Difference (RPD) - The MS relative percent difference is an indication of precision for the preparation and analysis.
ND	:	Non-detect - Result was below the DQO listed for the analyte.

Explanation

435	:	Sample matrix may be affecting this analyte. Data was accepted based on the LCS or CCV recovery.

Page 6 of 6

November 9, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B8 @ 25
Project : AGK0204

Lab ID : SP 2318471-001
Customer : 2022939

Sampled On : November 1, 2023
Sampled By : Client
Received On : November 3, 2023
Matrix : Water

General Irrigation Suitability Analysis

Test Description	Result				Graphical Results Presentation				
Cations	mg/L	Meq/L	% Meq	Lbs/AF	Good	Possible Problem	Moderate Problem	Increasing Problem	Severe Problem
Calcium	142	7.1	18	390	**				
Magnesium	102	8.4	22	280	**				
Potassium	10	0.26	1	27	**				
Sodium	523	23	59	1400					
Anions									
Carbonate	10	0.33	1	27					
Bicarbonate	30	0.49	1	82	**				
Sulfate	941	20	53	2600	**				
Chloride	570	16	43	1600					
Nitrate	34.0	0.55	1	92					
Nitrate Nitrogen	7.7			21					
Fluoride	0.2	0.011	0	0.5					
Minor Elements									
Boron	3.2			8.7					
Copper	<0.01			0					
Iron	<0.03			0					
Manganese	0.020			0.054					
Zinc	<0.02			0					
TDS by Summation	2370			6400					
Other									
pH	8.84	units							
E. C.	3.61	dS/m							
SAR	8.20								
Crop Suitability									
No Amendments	Poor								
With Amendments	Poor								
Amendments									
Gypsum Requirement	0.9	Tons/AF			Or 0.507 Tons/AF if Sulfuric Acid amendment applied.				
Sulfuric Acid (98%)	2.80	oz/1000Gal			Or 6.8 oz/1000Gal of urea Sulfuric Acid(15/49)				
Leaching Requirement	35	%							

Good — Problem

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.
** Used in various calculations; mg/L = Milligrams Per Liter (ppm) meq/L = Milliequivalents Per Liter.

November 9, 2023

BSK Associates Engineers & Laboratories

Description : B8 @ 25
Project : AGK0204

Lab ID : SP 2318471-001
Customer : 2022939

Sampled By : Client
Matrix : Water

Micro Irrigation System Plugging Hazard

Test Description	Result		Graphical Results Presentation
Chemical			Slight / Moderate / Severe
Manganese	0.02	mg/L	
Iron	<0.03	mg/L	
TDS by Summation	2370	mg/L	
No Amendments			
pH	8.84	units	
Alkalinity (As CaCO3)	40	mg/L	
Total Hardness	774	mg/L	
With Amendments			
Alkalinity (As CaCO3)	10	mg/L	
Total Hardness	8	mg/L	
pH	5.4 - 6.7	units	

Good — Problem

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

Water Amendments Application Notes:
The Amendments recommended on the previous pages include:

Gypsum:
This should be applied at least once a year to the irrigated soil surface area. Gypsum can also be applied in smaller quantities in the irrigation water.Apply the smaller (bracketed) amount of gypsum when also applying the recommended amount of Sulfuric Acid and the larger amount when applying only Gypsum.

Sulfuric Acid:
These products should be applied as needed to prevent emitter plugging in micro irrigation systems and/or as a soil amendment to adjust soil pH to improve nutrient availability and to facilitate leaching of salts. Please exercise caution when using this material as excesses may be harmful to the system and/or the plants being irrigated. The reported Acid requirement is intended to remove approximately 80 % of the alkalinity. The final pH should range from 5.4 to 6.7. We recommend a field pH determination to confirm that the pH you designate is being achieved. This application is based upon the use of a 98% Sulfuric Acid product. The application of Urea Sulfuric Acid is based upon the use of a product that contains 15% Urea (1.89 lbs Nitrogen), 49% Sulfuric Acid and has a specific gravity of 1.52 at 68 °F.
Please contact us if you have any questions.

BRW:EHB

Reviewed and Approved By **Ben Waddell**
Digitally signed by Ben Waddell
Title: Director of Ag. Services
Date: 2023-11-09

BSK ASSOCIATES

SUBCONTRACT ORDER

AGK0204

2314171

SENDING LABORATORY:

BSK Associates Laboratory Fresno
687 N. Laverne Avenue
Fresno, CA 93727
Phone: 559-497-2888
Fax: 559-485-6935
Project Manager: Elaine M. Phillips
E-mail: ephillips@bskassociates.com

RECEIVING LABORATORY:

FGL Environmental
P.O. Box 272 / 853 Corporation
Santa Paula, CA 93060
Phone :(805) 392-2000
Fax: (805) 525-4172
Turnaround (Days): 7
QC Deliverables: I Std III IV

Lab Filter for dissolved metals please!

Sample ID	Samp Desc		Sample Date
AGK0204-01	B8 @ 25'	Client Matrix: Water Sampled By: Client	11/01/2023 11:19

Lab Matrix: Water

Analysis:

Alkalinity as CaCO3
Arsenic, CA DW ICPMS Dissolved
Boron, CA DW ICP Dissolved
Calcium, CA DW ICP Dissolved
Copper, CA DW ICPMS Dissolved
EC, Conductivity
Fluoride, Wastewater
Iron, CA DW ICP Dissolved
Magnesium, CA DW ICP Dissolved
Percent Sodium
pH, Drinking and Wastewaters
Potassium, CA DW ICP Dissolved
Sodium Absorption Ratio
Sodium, CA DW ICP Dissolved
TDS, Total Dissolved Solids
Zinc, CA DW ICPMS Dissolved

} Irrigation Suitability*

Known

State Forms: **No** System Name: _____

*BSK analyzed Nitrate in house to meet H.T. will provide results for calculation.

Released By	Date	Received By	Date
[signature] 11.2.23			
[signature]	11/3/23 11:00	[signature]	11/3/23 11:00
Released By	Date	Received By	Date

Condition Upon Receipt (Attach to COC) SP 2318471

Sample Receipt at SP:

1. Number of ice chests/packages received: **1**
2. Shipper tracking numbers _____
3. Were samples received in a chilled condition?
   Temps: **6** /_____/_____/_____/_____/_____/_____/_____

4. Surface water (SWTR) bact samples: A sample that has a temperature upon receipt of >10C, whether iced or not, should be flagged unless the time since sample collection has been less than two hours.

5. Do the number of bottles received agree with the COC?	**Yes**	**No**	**N/A**
6. Verify sample date, time, sampler	**Yes**	**No**	**N/A**
7. Were the samples received intact? (i.e. no broken bottles, leaks, etc.)	**Yes**	**No**	
8. Were sample custody seals intact?	**Yes**	**No**	**N/A**

Sample Verification, Labeling and Distribution:

1. Were all requested analyses understood and acceptable?	**Yes**	**No**		
2. Did bottle labels correspond with the client's ID's?	**Yes**	**No**		
3. Were all bottles requiring sample preservation properly preserved? [Exception: Oil & Grease, VOA and CrVI verified in lab]	**Yes**	**No**	**N/A**	**FGL**
4. VOAs checked for Headspace?	**Yes**	**No**	**N/A**	
5. Were all analyses within holding times at time of receipt?	**Yes**	**No**		
6. Have rush or project due dates been checked and accepted?	**Yes**	**No**	**N/A**	

Include a copy of the COC for lab delivery. (Bacti. Inorganics and Radio)

Sample Receipt, Login and Verification completed by: Reviewed and Approved By **Inez Covarrubias** Digitally signed by Inez Covarrubias Title: Sample Receiving Date: 11/06/2023-09:31:12

Discrepency Documentation:

Any items above which are "No" or do not meet specifications (i.e. temps) must be resolved.

1. Person Contacted: _____ Phone Number: _____
   Initiated By: _____ Date: _____
   Problem:

   Resolution: **Client aware of NO3 hold time**

2. Person Contacted: _____ Phone Number: _____
   Initiated By: _____ Date: _____
   Problem:

   Resolution:

(2022939)
BSK Associates
SP 2318471
IV/CDA-11/06/2023-09:31:12

Case Narrative

Project and Report Details		Invoice Details	
Client:	BSK Associates - Fresno	**Invoice To:**	BSK Associates - Corporate
Report To:	Neva Popenoe	**Invoice Attn:**	BSK Associates-Corp
Project #:	G00001262	**Project PO#:**	-
Received:	11/02/2023 - 16:00		
Report Due:	11/20/2023		

Sample Receipt Conditions

Cooler: Default Cooler

Temperature on Receipt ºC: 0.9

Containers Intact
COC/Labels Agree
Preservation Confirmed
Received On Wet Ice
Sample(s) arrived at lab on same day sampled.
Packing Material - Other
Sample(s) were received in temperature range.
Initial receipt at BSK-FAL

Data Qualifiers

The following qualifiers have been applied to one or more analytical results:

None applied

Report Distribution

Recipient(s)	Report Format	CC:
Neva Popenoe	FINAL.RPT	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Sample ID: AGK0331-01RE1
Sampled By: Darren Ferrer
Sample Description: B-1 @ 20'

Sample Date - Time: 11/02/2023 - 09:00
Matrix: Ground Water
Sample Type: Grab

BSK Associates Laboratory Fresno

General Chemistry

Analyte	Method	Result	RL	Units	RL Mult	Batch	Prepared	Analyzed	Qual
Hexavalent Chromium - Dissolved (1)	EPA 218.6	**6.0**	0.050	ug/L	1	AGK0984	11/15/23	11/15/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Sample ID: AGK0331-02RE1
Sampled By: Darren Ferrer
Sample Description: B-3 @ 30'

Sample Date - Time: 11/02/2023 - 12:30
Matrix: Ground Water
Sample Type: Grab

BSK Associates Laboratory Fresno

General Chemistry

Analyte	Method	Result	RL	Units	RL Mult	Batch	Prepared	Analyzed	Qual
Hexavalent Chromium - Dissolved (1)	EPA 218.6	**44**	0.50	ug/L	10	AGK0984	11/15/23	11/15/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Sample ID: AGK0331-03RE1
Sampled By: Darren Ferrer
Sample Description: B-5 @ 20'

Sample Date - Time: 11/02/2023 - 11:00
Matrix: Ground Water
Sample Type: Grab

BSK Associates Laboratory Fresno

General Chemistry

Analyte	Method	Result	RL	Units	RL Mult	Batch	Prepared	Analyzed	Qual
Hexavalent Chromium - Dissolved (1)	EPA 218.6	**60**	0.50	ug/L	10	AGK0984	11/15/23	11/15/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

BSK Associates Laboratory Fresno

General Chemistry Quality Control Report

Analyte	Result	RL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Date Analyzed	Qual
EPA 218.6 - Quality Control											
Batch: AGK0921										Prepared: 11/14/2023	
Prep Method: Method Specific Preparation										Analyst: CTD	
Blank (AGK0921-BLK1)											
Hexavalent Chromium - Dissolved (1)	ND	0.050	ug/L							11/14/23	
Blank Spike (AGK0921-BS1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	102	90-110			11/14/23	
Blank Spike Dup (AGK0921-BSD1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	101	90-110	1	10	11/14/23	
Matrix Spike (AGK0921-MS1), Source: AGK1519-01											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	99	90-110			11/14/23	
Matrix Spike Dup (AGK0921-MSD1), Source: AGK1519-01											
Hexavalent Chromium - Dissolved (1)	2.1	0.050	ug/L	2.0	ND	106	90-110	7	10	11/14/23	
EPA 218.6 - Quality Control											
Batch: AGK0984										Prepared: 11/15/2023	
Prep Method: Method Specific Preparation										Analyst: CTD	
Blank (AGK0984-BLK1)											
Hexavalent Chromium - Dissolved (1)	ND	0.050	ug/L							11/15/23	
Blank Spike (AGK0984-BS1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	101	90-110			11/15/23	
Blank Spike Dup (AGK0984-BSD1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	102	90-110	1	10	11/15/23	
Matrix Spike (AGK0984-MS1), Source: AGK0479-01RE1											
Hexavalent Chromium - Dissolved (1)	3.8	0.050	ug/L	2.0	1.9	95	90-110			11/15/23	
Matrix Spike Dup (AGK0984-MSD1), Source: AGK0479-01RE1											
Hexavalent Chromium - Dissolved (1)	3.9	0.050	ug/L	2.0	1.9	99	90-110	2	10	11/15/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Notes:

- The Chain of Custody document and Sample Integrity Sheet are part of the analytical report.
- Any remaining sample(s) for testing will be disposed of according to BSK's sample retention policy unless other arrangements are made in advance.
- All positive results for EPA Methods 504.1 and 524.2 require the analysis of a Field Reagent Blank (FRB) to confirm that the results are not a contamination error from field sampling steps. If Field Reagent Blanks were not submitted with the samples, this method requirement has not been performed.
- Samples collected by BSK Analytical Laboratories were collected in accordance with the BSK Sampling and Collection Standard Operating Procedures.
- J-value is equivalent to DNQ (Detected, not quantified) which is a trace value. A trace value is an analyte detected between the MDL and the laboratory reporting limit. This result is of an unknown data quality and is only qualitative (estimated). Baseline noise, calibration curve extrapolation below the lowest calibrator, method blank detections, and integration artifacts can all produce apparent DNQ values, which contribute to the un-reliability of these values.
- (1) - Residual chlorine and pH analysis have a 15 minute holding time for both drinking and waste water samples as defined by the EPA and 40 CFR 136. Waste water and ground water (monitoring well) samples must be field filtered to meet the 15 minute holding time for dissolved metals.
- Field tests are outside the scope of laboratory accreditation and there is no certification available for field testing.
- Summations of analytes (i.e. Total Trihalomethanes) may appear to add individual amounts incorrectly, due to rounding of analyte values occurring before or after the total value is calculated, as well as rounding of the total value.
- RL Multiplier is the factor used to adjust the reporting limit (RL) due to variations in sample preparation procedures and dilutions required for matrix interferences.
- Due to the subjective nature of the Threshold Odor Method, all characterizations of the detected odor are the opinion of the panel of analysts. The characterizations can be found in Standard Methods 2170B Figure 2170:1.
- The MCLs provided in this report (if applicable) represent the primary MCLs for that analyte.
- (2) - Formerly known as Bis(2-Chloroisopropyl) ether.

Unless otherwise noted, TOC results by SM 5310C method do not include purgeable organic carbon, which is removed along with the inorganic carbon interference. The POC contribution to TOC is considered to be negligible.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Definitions

mg/L:	Milligrams/Liter (ppm)	MDL:	Method Detection Limit	MDA95:	Min. Detected Activity
mg/Kg:	Milligrams/Kilogram (ppm)	RL:	Reporting Limit: DL x Dilution	MPN:	Most Probable Number
µg/L:	Micrograms/Liter (ppb)	ND:	None Detected below MRL/MDL	CFU:	Colony Forming Unit
µg/Kg:	Micrograms/Kilogram (ppb)	pCi/L:	PicoCuries per Liter	Absent:	Less than 1 CFU/100mLs
%:	Percent	RL Mult:	RL Multiplier	Present:	1 or more CFU/100mLs
NR:	Non-Reportable	MCL:	Maximum Contaminant Limit	U:	The analyte was not detected at or above the reported sample quantitation limit.

Please see the individual Subcontract Lab's report for applicable certifications.

The following parameters are not available for certification through CA ELAP:

Odor Diisopropyl ether (DIPE) by EPA 524.2

The following parameters are calculated values and are outside the scope of our NELAP accreditation:

Total Nitrogen Aggressive Index Trivalent Chromium

BSK is not accredited under the NELAP program for the following additional parameters: **NA**

Certifications: **Please refer to our website for a copy of our Accredited Fields of Testing under each certification.**

Fresno

State of California - ELAP	1180	State of Hawaii	4021
Los Angeles CSD	9254479	NELAP certified	4021-022
State of Nevada	CA000792024-03	State of Oregon - NELAP	4021-022
EPA UCMR5	CA00079	State of Washington	C997-23

Sacramento

State of California - ELAP	1180-S1		

San Bernardino

State of California - ELAP	1180-S2	Los Angeles CSD	9254478
NELAP certified	4119-008	State of Oregon - NELAP	4119-008

Vancouver

NELAP certified	WA100008-016	State of Oregon - NELAP	WA100008-016
State of Washington	C824-23		

Sample Integrity

BSK Bottles: Yes No Page 1 of 1

COC Info

Was temperature within range? Chemistry ≤ 6°C Micro < 8°C	Yes No NA	Were correct containers and preservatives received for the tests requested?	Yes No NA
If samples were taken today, is there evidence that chilling has begun?	Yes No NA	Bubbles Present VOAs (524.2/TTHM/TCP)? TB Received? (Check Method Below)	Yes No NA Yes No NA
Did all bottles arrive unbroken and intact?	Yes No	Was a sufficient amount of sample received?	Yes No
Did all bottle labels agree with COC?	Yes No	Do samples have a hold time <72 hours?	Yes No
Was sodium thiosulfate added to CN sample(s) until chlorine was no longer present?	Yes NA	Was PM notified of discrepancies? PM: By/Time:	Yes No NA

Bottles Received

"—" means preservation/chlorine checks are either N/A or are performed in the lab

250ml(A) 500ml(B) 1Liter(C) 40mlVOA(V) 125ml(D)	Checks*	Passed?	1-3				
Bacti $Na_2S_2O_3$	—	—					
None (P) White Cap	—	—	1C, 1B				
Cr6 (P) Lt. Green Label/Blue Cap $NH_4OH(NH_4)_2SO_4$ **DW**	Cl, pH > 8	P F					
Cr6 (P) Pink Label/Blue Cap $NH_4OH(NH_4)_2SO_4$ **WW**	pH 9.3-9.7	P F	1A				
Cr6 (P) Black Label/Blue Cap $NH_4OH(NH_4)_2SO_4$ **7199** ***24 HOUR HOLD TIME***	pH 9.0-9.5	P F					
HNO_3 (P) Red Cap or HCl (P) Purple Cap/Lt. Blue Label	—	—					
H_2SO_4 (P) or (AG) Yellow Cap/Label	pH < 2	P F					
NaOH (P) Green Cap	Cl, pH >10	P F					
NaOH + ZnAc (P)	pH > 9	P F					
Dissolved Oxygen 300ml (g)	—	—					
None (AG) 608/8081/8082, 625, 632/8321, 8151, 8270	—	—					
HCl (AG) Lt. Blue Label O&G, Diesel, **TCP**	—	—					
Ascorbic, EDTA, KH_2Ct (AG) Pink Label 525	—	—					
Na_2SO_3 250mL (AG) Neon Green Label 515	—	—					
$Na_2S_2O_3$ 1 Liter (Brown P) 549	—	—					
$Na_2S_2O_3$ (AG) Blue Label 548, THM, 524	—	—					
$Na_2S_2O_3$ (CG) Blue Label 504, 505, 547	—	—					
$Na_2S_2O_3$ + MCAA (CG) Orange Label 531	pH < 3	P F					
NH_4Cl (AG) Purple Label 552	—	—					
EDA (P) or (AG) Brown Label DBPs	—	—					
HCL (CG) 524.2,BTEX,Gas, MTBE, 8260/624	—	—					
Buffer pH 4 (CG)	—	—					
H_3PO_4 (CG) Salmon Label	—	—					
Trizma – EPA 537.1 Light Blue Label **FB**	---	---					
Ammonia Acetate - EPA 533 Purple Label **FB**	---	---					
Bottled Water	—	—					
Asbestos 1L (P) w/ Foil / LL Metals Bottle	—	—					
Clear Glass	—	—					
OTHER:	—	—					

Split

	Container	Preservative	Lot #	Initials	Date/Time
S P					
S P					

Preservation Check
pH Lot # AG04915
Cl Lot # AG09231

Comments

*Preservation check completed by lab performing analysis.

✓ **Indicates Blanks Received**

504 ___ 524.2 ___ TTHM ___ 537/533 ___ TCP___

✓ **MS/MSD Received Method:** _____

Labeled by: **Labels Checked by:**

Scanned: SB Rush/Short HT Page: _____ Time: _____

BSK ASSOCIATES
687 N. Laverne Ave., Fresno, CA 93727
(559) 497-2888 CA ELAP No. 1180
www.bskassociates.com

Turnaround Time Request
☒ Standard - 10 business days
☐ Rush (Surcharge may apply)
Date needed:

Temp: 0.9 °C Thermometer ID: 77

*Required Fields

Company/Client Name*:	Report Attention*:	Invoice To*:	Phone*:	Fax:
BSK Associates - Fresno	Neva Popenoe Additional cc's:	BSK Associates - Corp PO#:	(559) 497-2880 E-mail*: npopenoe@bskassociates.com	

Address*:	City*:	State*:	Zip*:
691 N. Laverne Ave, Suite 101	Fresno	CA	93727

Project:	Project #:	Phase #	Task #:
Los Banos Santa Fe Grade Basin	G00001262		

Reporting Options: ☐ Trace (J-Flag) ☐ Swamp ☐ EDD Type: _____

Sampler Name (Printed/Signature)*: Darren Ferrer

Regulatory Carbon Copies: ☐ SWRCB (Drinking Water) ☐ Merced Co ☐ Fresno Co ☐ Madera Co ☐ Tulare Co ☐ Other: _____

Regulatory Compliance: ☐ EDT to California SWRCB (Drinking Water) System Number*: _____ ☐ Geotracker #: _____

Matrix Types: SW=Surface Water BW=Bottled Water GW=Ground Water WW=Waste Water STW=Storm Water DW=Drinking Water SO=Solid

#	Sample Description*	Sampled* Date	Sampled* Time	Matrix*	Comments / Station Code / WTRAX	Irrigation Water, Ag Suitability Dissolved	Dissolved: As, Se	Hex Chrom 218.6 Dissolved	Gypsum					
	B-1 @ 20'	11/2/23	9:00a	GW		X	X	X	X					
	B-3 @ 30'	11/2/23	12:30p	GW		X	X	X	X					
	B-5 @ 20'	11/2/23	11:00a	GW		X	X	X	X					

Relinquished by: (Signature and Printed Name)	Company	Date	Time	Received by: (Signature and Printed Name)	Company
Darren Ferrer	BSK	11/2/23	4:00p		
Relinquished by: (Signature and Printed Name)	Company	Date	Time	Received by: (Signature and Printed Name)	Company
Received for Lab by: (Signature and Printed Name)		Date	Time	Payment Received at Delivery: Check / Cash Date: Amount: PIA#: Init.	
		11/2/23	1650		

Shipping Method: GLS UPS WALK-IN FED EX PMS Courier: BSK

Cooling Method: Wet Blue None

Custody Seal: Y / N

Chilling Process Begun: Y / N

Payment for services rendered as noted herein are due in full within 30 days from the date invoiced. If not so paid, account balances are deemed delinquent. Delinquent balances are subject to monthly service charges and interest specified in BSK's current Standard Terms and Conditions for Laboratory Services. The person signing for the Client/Company acknowledges that they are either the Client or an authorized agent to the Client, that the Client agrees to be responsible for payment for the services on this Chain of Custody, and agrees to BSK's terms and conditions for laboratory services unless contractually bound otherwise. BSK's current terms and conditions can be found at www.bskassociates.com/BSKLabTermsConditions.pdf

November 13, 2023

Lab No. : SP 2318473
Customer No. : 2022939

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Laboratory Report

Introduction: This report package contains a total of 8 pages divided into 3 sections:

Case Narrative	(2 pages)	: An overview of the work performed at FGL.
Sample Results	(3 pages)	: Results for each sample submitted.
Quality Control	(3 pages)	: Supporting Quality Control (QC) results.

Case Narrative

This Case Narrative pertains to the following samples:

Sample Description	Date Sampled	Date Received	FGL Lab No.	Matrix
B-1 @ 20'	11/02/2023	11/03/2023	SP 2318473-001	GW
B-3 @ 30'	11/02/2023	11/03/2023	SP 2318473-002	GW
B-5 @ 20'	11/02/2023	11/03/2023	SP 2318473-003	GW

Sampling and Receipt Information:

All samples were received in acceptable condition and within temperature requirements, unless noted on the Condition Upon Receipt (CUR) form. All samples were received, prepared and analyzed within the method specified holding times except those as listed in the table below. All samples arrived at 6 ° C. All samples were checked for pH if acid or base preservation is required (except for VOAs). For details of sample receipt information, please see the associated Chain of Custody and Condition Upon Receipt Form.

Samples Over Hold Time

Lab No	Analyte Method	Maximum Hold Time	Actual Hold Time
SP 2318473-001	Nitrate	48 hours	100.5 hours
SP 2318473-001	Nitrate Nitrogen	48 hours	100.5 hours
SP 2318473-001	pH	15 minutes	6,216.0 minutes
SP 2318473-002	Nitrate	48 hours	97.0 hours
SP 2318473-002	Nitrate Nitrogen	48 hours	97.0 hours
SP 2318473-002	pH	15 minutes	6,006.0 minutes
SP 2318473-003	Nitrate	48 hours	98.5 hours
SP 2318473-003	Nitrate Nitrogen	48 hours	98.5 hours
SP 2318473-003	pH	15 minutes	6,096.0 minutes

Quality Control: All samples were prepared and analyzed according to established quality control criteria. Any exceptions are noted in the Quality Control Section of this report.

Test Summary

EPA 200.7	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
EPA 200.8	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
EPA 300.0	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)

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FAX: (559)734-8435
CA ELAP Certification No. 2810

SM 2540 C	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
SM 4500-H+B	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)

Certification: I certify that this data package is in compliance with ELAP standards, both technically and for completeness, except for any conditions listed above and in the QC Section. Release of the data contained in this data package is authorized by the Laboratory Director or his designee, as verified by the following electronic signature. This report shall not be reproduced except in full, without the written approval of the laboratory.

KD: MKH

Approved By **Kelly A. Dunnahoo, B.S.** Digitally signed by Kelly A. Dunnahoo, B.S.
Title: Laboratory Director
Date: 2023-11-13

Page 2 of 8

November 13, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-1 @ 20'
Project : AGK0331

Lab No. : SP 2318473-001
Customer No. : 2022939

Sampled On : November 2, 2023 at 09:00
Sampled By : Darren Ferrer
Received On : November 3, 2023 at 11:00
Matrix : Ground Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
Irrigation Suit							Date	Time	Who	Method	Date	Time	Who
Total Hardness as CaCO3	352	2.5	mg/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:30	ac
Calcium	72	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:30	ac
Magnesium	42	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:30	ac
Potassium	3	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:30	ac
Sodium	192	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:30	ac
Total Cations	15.5	---	meq/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:30	ac
Boron	1.0	0.1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:30	ac
Copper	ND	10	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:30	ac
Iron	ND	30	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:30	ac
Manganese	ND	10	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:30	ac
Zinc	ND	20	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:30	ac
Gypsum Requirement	0.5	0.01	Tons/AF		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:30	ac
SAR	4.4	0.1	--		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:30	ac
Total Alkalinity	150	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	21:24	amm
Hydroxide	ND	10	mg/L		1	U	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	21:24	amm
Carbonate	ND	10	mg/L		1	U	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	21:24	amm
Bicarbonate	190	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	21:24	amm
Sulfate	346	2.5*	mg/L		5		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	08:01	ldm
Chloride	220	5*	mg/L		5		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	08:01	ldm
Nitrate	7.4	0.4	mg/L		1	T	11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	01:44	ldm
Nitrate Nitrogen	1.7	0.1	mg/L		1	T	11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	01:44	ldm
Fluoride	0.2	0.1	mg/L		1		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	01:44	ldm
Total Anions	16.7	---	meq/L		1		11/06/2023	16:36	amm	Calc.	11/06/2023	21:24	amm
pH	8.3	---	units		1	T	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	21:24	amm
E. C.	1680	1	umhos/cm		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	21:24	amm
TDS by Summation	1070	0	mg/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:30	ac
Metals, Diss													
Arsenic	11	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/10/2023	14:07	ac
Selenium	4	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/09/2023	11:47	ac
Wet Chemistry													
Total Dissolved Solids (TFR)	1120	20	mg/L		1		11/09/2023	11:45	ctl	SM 2540 C	11/10/2023	11:00	ctl

DQF Flags Definition:
U Constituent results were non-detect.
T Exceeded method/regulatory-specific holding time.
h The MS/MSD did not meet QC criteria.

ND=Non-Detected, RL=Reporting Level * RL adjusted for dilution, Dil.=Dilution

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FAX: (559)734-8435
CA ELAP Certification No. 2810

November 13, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-3 @ 30'
Project : AGK0331

Lab No. : SP 2318473-002
Customer No. : 2022939

Sampled On : November 2, 2023 at 12:30
Sampled By : Darren Ferrer
Received On : November 3, 2023 at 11:00
Matrix : Ground Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
Irrigation Suit							Date	Time	Who	Method	Date	Time	Who
Total Hardness as CaCO3	1370	2.5	mg/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:37	ac
Calcium	236	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:37	ac
Magnesium	190	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:37	ac
Potassium	11	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:37	ac
Sodium	1040	5*	mg/L		5		11/06/2023	09:00	ac	EPA 200.7	11/08/2023	12:32	ac
Total Cations	72.9	---	meq/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:37	ac
Boron	8.9	0.1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:37	ac
Copper	ND	10	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:37	ac
Iron	ND	30	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:37	ac
Manganese	40	10	ug/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:37	ac
Zinc	ND	20	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:37	ac
Gypsum Requirement	3.8	0.01	Tons/AF		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:37	ac
SAR	12.2	0.1	--		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:37	ac
Total Alkalinity	730	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:51	amm
Hydroxide	ND	10	mg/L		1	U	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:51	amm
Carbonate	ND	10	mg/L		1	U	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:51	amm
Bicarbonate	900	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:51	amm
Sulfate	1760	10.5*	mg/L		20		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	08:20	ldm
Chloride	960	21*	mg/L		20		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	08:20	ldm
Nitrate	31.0	0.4	mg/L		1	T	11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	02:44	ldm
Nitrate Nitrogen	7.0	0.1	mg/L		1	T	11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	02:44	ldm
Fluoride	0.2	0.1	mg/L		1		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	02:44	ldm
Total Anions	79.0	---	meq/L		1		11/06/2023	16:36	amm	Calc.	11/06/2023	20:51	amm
pH	7.82	---	units		1	T	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:51	amm
E. C.	6780	1	umhos/cm		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:51	amm
TDS by Summation	5130	0	mg/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:37	ac
Metals, Diss													
Arsenic	13	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/10/2023	14:14	ac
Selenium	22	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/09/2023	11:54	ac
Wet Chemistry													
Total Dissolved Solids (TFR)	5370	20	mg/L		1		11/09/2023	11:45	ctl	SM 2540 C	11/10/2023	11:00	ctl

DQF Flags Definition:
U Constituent results were non-detect.
T Exceeded method/regulatory-specific holding time.
h The MS/MSD did not meet QC criteria.

ND=Non-Detected, RL=Reporting Level * RL adjusted for dilution, Dil.=Dilution

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November 13, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-5 @ 20'
Project : AGK0331

Lab No. : SP 2318473-003
Customer No. : 2022939

Sampled On : November 2, 2023 at 11:00
Sampled By : Darren Ferrer
Received On : November 3, 2023 at 11:00
Matrix : Ground Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
Irrigation Suit							Date	Time	Who	Method	Date	Time	Who
Total Hardness as CaCO3	764	2.5	mg/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:44	ac
Calcium	123	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:44	ac
Magnesium	111	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:44	ac
Potassium	7	1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:44	ac
Sodium	797	5*	mg/L		5		11/06/2023	09:00	ac	EPA 200.7	11/08/2023	12:39	ac
Total Cations	50.1	---	meq/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:44	ac
Boron	5.0	0.1	mg/L		1		11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:44	ac
Copper	ND	10	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:44	ac
Iron	ND	30	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:44	ac
Manganese	ND	10	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:44	ac
Zinc	ND	20	ug/L		1	U	11/06/2023	09:00	ac	EPA 200.7	11/06/2023	13:44	ac
Gypsum Requirement	3.1	0.01	Tons/AF		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:44	ac
SAR	12.5	0.1	--		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:44	ac
Total Alkalinity	330	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:39	amm
Hydroxide	ND	10	mg/L		1	U	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:39	amm
Carbonate	ND	10	mg/L		1	U	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:39	amm
Bicarbonate	400	10	mg/L		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:39	amm
Sulfate	926	6.5*	mg/L		10		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	08:40	ldm
Chloride	600	13*	mg/L		10		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	08:40	ldm
Nitrate	30.7	0.4	mg/L		1	T	11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	03:04	ldm
Nitrate Nitrogen	6.9	0.1	mg/L		1	T	11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	03:04	ldm
Fluoride	0.2	0.1	mg/L		1		11/06/2023	13:31	ldm	EPA 300.0	11/07/2023	03:04	ldm
Total Anions	43.3	---	meq/L		1		11/06/2023	16:36	amm	Calc.	11/06/2023	20:39	amm
pH	8.17	---	units		1	T	11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:39	amm
E. C.	4070	1	umhos/cm		1		11/06/2023	16:36	amm	SM 4500-H+B	11/06/2023	20:39	amm
TDS by Summation	2990	0	mg/L		1		11/06/2023	09:00	ac	Calc.	11/06/2023	13:44	ac
Metals, Diss													
Arsenic	16	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/10/2023	14:21	ac
Selenium	13	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/09/2023	12:00	ac
Wet Chemistry													
Total Dissolved Solids (TFR)	2870	20	mg/L		1		11/09/2023	11:45	ctl	SM 2540 C	11/10/2023	11:00	ctl

DQF Flags Definition:
U Constituent results were non-detect.
T Exceeded method/regulatory-specific holding time.
h The MS/MSD did not meet QC criteria.

ND=Non-Detected, RL=Reporting Level * RL adjusted for dilution, Dil.=Dilution

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November 13, 2023
BSK Associates

Lab No. : SP 2318473
Customer No. : 2022939

Quality Control - Metals

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Metals								
Boron	200.7	11/06/2023:212572AC	MS	mg/L	4.000	91.9%	75-125	
		(SP 2318527-006)	MSD	mg/L	4.000	98.6%	75-125	
			MSRPD	mg/L		6.1%	≤20.0	
Calcium	200.7	11/06/2023:212572AC	MS	mg/L	12.00	46.9%	<¼	406
		(SP 2318527-006)	MSD	mg/L	12.00	69.8%	<1/4	
			MSRPD	mg/L		2.1%	≤20.0	
Copper	200.7	11/06/2023:212572AC	MS	ug/L	800.0	93.9%	75-125	
		(SP 2318527-006)	MSD	ug/L	800.0	101%	75-125	
			MSRPD	ug/L		7.6%	≤20.0	
Iron	200.7	11/06/2023:212572AC	MS	ug/L	4000	83.2%	75-125	
		(SP 2318527-006)	MSD	ug/L	4000	92.8%	75-125	
			MSRPD	ug/L		10.9%	≤20.0	
Magnesium	200.7	11/06/2023:212572AC	MS	mg/L	12.00	76.7%	75-125	
		(SP 2318527-006)	MSD	mg/L	12.00	87.7%	75-125	
			MSRPD	mg/L		2.7%	≤20.0	
Manganese	200.7	11/06/2023:212572AC	MS	ug/L	800.0	95.5%	75-125	
		(SP 2318527-006)	MSD	ug/L	800.0	103%	75-125	
			MSRPD	ug/L		5.9%	≤20.0	
Potassium	200.7	11/06/2023:212572AC	MS	mg/L	12.00	91.1%	75-125	
		(SP 2318527-006)	MSD	mg/L	12.00	99.2%	75-125	
			MSRPD	mg/L		5.6%	≤20.0	
Sodium	200.7	11/06/2023:212572AC	MS	mg/L	12.00	55.4%	<¼	406
		(SP 2318527-006)	MSD	mg/L	12.00	77.2%	75-125	
			MSRPD	mg/L		2.6%	≤20.0	
Zinc	200.7	11/06/2023:212572AC	MS	ug/L	800.0	87.9%	75-125	
		(SP 2318527-006)	MSD	ug/L	800.0	92.5%	75-125	
			MSRPD	ug/L		4.9%	≤20.0	
Arsenic	200.8	11/09/2023:212732AC	MS	ug/L	5.000	553%	75-125	435
		(CH 2379204-001)	MSD	ug/L	5.000	638%	75-125	435
			MSRPD	ug/L		14.2%	≤20	
Selenium	200.8	11/09/2023:212732AC	MS	ug/L	5.000	578%	75-125	435
		(CH 2379204-001)	MSD	ug/L	5.000	603%	75-125	435
			MSRPD	ug/L		4.2%	≤20	

Definition

DQO : Data Quality Objective - This is the criteria against which the quality control data is compared.

MS : Matrix Spikes - A random sample is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.

MSD : Matrix Spike Duplicate of MS/MSD pair - A random sample duplicate is spiked with a known amount of analyted. The recoveries are an indication of how that sample matrix affects analyte recovery.

MSRPD : MS/MSD Relative Percent Difference (RPD) - The MS relative percent difference is an indication of precision for the preparation and analysis.

ND : Non-detect - Result was below the DQO listed for the analyte.

Explanation

406 : Matrix Spike (MS) not within the Acceptance Range (AR) because of high analyte concentration in the sample. Data was accepted based on the LCS or CCV recovery.

435 : Sample matrix may be affecting this analyte. Data was accepted based on the LCS or CCV recovery.

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November 13, 2023
BSK Associates

Lab No. : SP 2318473
Customer No. : 2022939

Quality Control - Wet Chem

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Wet Chem								
Alkalinity (as CaCO3)	2320B	11/06/2023:212619AMM	ND	mg/L		1.25%	10	435
Bicarbonate	2320B	(SP 2318491-001)	Dup	mg/L		1.25%	10	
E. C.	2320B	(SP 2318491-001)	Dup	umhos/cm		0.2%	5	
pH	2320B	(SP 2318491-001)	Dup	units		1.11%	4.80	
Solids, Total Dissolved	2540CE	11/09/2023:212748CTL	Blank	mg/L		ND	<20	
			LCS	mg/L	991.5	101%	90-110	
		(SP 2318698-001)	Dup	mg/L		0.2%	5	
		(SP 2318698-001)	Dup	mg/L		1.16%	5	
Chloride	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<1	
			LCS	mg/L	25.00	102%	90-110	
			MS	mg/L	50.00	102%	67-117	
		(CH 2379032-008)	MSD	mg/L	50.00	102%	67-117	
			MSRPD	mg/L		0.0%	≤7	
			MS	mg/L	50.00	103%	67-117	
		(STK2354964-004)	MSD	mg/L	50.00	103%	67-117	
			MSRPD	mg/L		0.2%	≤7	
Fluoride	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<0.1	
			LCS	mg/L	2.500	102%	90-110	
			MS	mg/L	5.000	99.6%	89-111	
		(CH 2379032-008)	MSD	mg/L	5.000	97.2%	89-111	
			MSRPD	mg/L		1.7%	≤9	
			MS	mg/L	5.000	103%	89-111	
		(STK2354964-004)	MSD	mg/L	5.000	101%	89-111	
			MSRPD	mg/L		1.7%	≤9	
Nitrate	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<0.4	
			LCS	mg/L	20.00	100%	90-110	
			MS	mg/L	40.00	103%	86-112	
		(CH 2379032-008)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.0%	≤7	
			MS	mg/L	40.00	103%	86-112	
		(STK2354964-004)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.0%	≤7	
Nitrate Nitrogen	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<0.4	
			LCS	mg/L	20.00	100%	90-110	
			MS	mg/L	40.00	103%	86-112	
		(CH 2379032-008)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.0%	≤7	
			MS	mg/L	40.00	103%	86-112	
		(STK2354964-004)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.0%	≤7	
Sulfate	300.0	11/06/2023:212615LDM	Blank	mg/L		ND	<0.5	
			LCS	mg/L	50.00	103%	90-110	
			MS	mg/L	100.0	102%	18-165	
		(CH 2379032-008)	MSD	mg/L	100.0	103%	18-165	
			MSRPD	mg/L		0.1%	≤7	
			MS	mg/L	100.0	104%	18-165	
		(STK2354964-004)	MSD	mg/L	100.0	104%	18-165	
			MSRPD	mg/L		0.3%	≤7	

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Definition

Blank	:	Method Blank - Prepared to verify that the preparation process is not contributing contamination to the samples.
Dup	:	Duplicate Sample - A random sample with each batch is prepared and analyzed in duplicate. The relative percent difference is an indication of precision for the preparation and analysis.
LCS	:	Laboratory Control Standard/Sample - Prepared to verify that the preparation process is not affecting analyte recovery.
MS	:	Matrix Spikes - A random sample is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.
MSD	:	Matrix Spike Duplicate of MS/MSD pair - A random sample duplicate is spiked with a known amount of analyted. The recoveries are an indication of how that sample matrix affects analyte recovery.
MSRPD	:	MS/MSD Relative Percent Difference (RPD) - The MS relative percent difference is an indication of precision for the preparation and analysis.
ND	:	Non-detect - Result was below the DQO listed for the analyte.

Explanation

435	:	Sample matrix may be affecting this analyte. Data was accepted based on the LCS or CCV recovery.

Page 8 of 8

November 9, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-1 @ 20'
Project : AGK0331

Lab ID : SP 2318473-001
Customer : 2022939

Sampled On : November 2, 2023
Sampled By : Darren Ferrer
Received On : November 3, 2023
Matrix : Ground Water

General Irrigation Suitability Analysis

Test Description	Result				Graphical Results Presentation				
Cations	mg/L	Meq/L	% Meq	Lbs/AF	Good	Possible Problem	Moderate Problem	Increasing Problem	Severe Problem
Calcium	72	3.6	23	200	**				
Magnesium	42	3.5	22	110	**				
Potassium	3	0.077	0	8	**				
Sodium	192	8.4	54	520					
Anions									
Carbonate	<10	0	0	0					
Bicarbonate	190	3.1	19	520	**				
Sulfate	346	7.2	43	940	**				
Chloride	220	6.2	37	600					
Nitrate	7.4	0.12	1	20					
Nitrate Nitrogen	1.7			5					
Fluoride	0.2	0.011	0	0.5					
Minor Elements									
Boron	1.0			2.7					
Copper	<0.01			0					
Iron	<0.03			0					
Manganese	<0.01			0					
Zinc	<0.02			0					
TDS by Summation	1070			2900					
Other									
pH	8.3	units							
E. C.	1.68	dS/m							
SAR	4.40								
Crop Suitability									
No Amendments	Poor								
With Amendments	Poor								
Amendments									
Gypsum Requirement	0.5	Tons/AF							
Sulfuric Acid (98%)	10.0	oz/1000Gal			Or 25 oz/1000Gal of urea Sulfuric Acid(15/49)				
Leaching Requirement	14	%							

Good — Problem

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.
** Used in various calculations; mg/L = Milligrams Per Liter (ppm) meq/L = Milliequivalents Per Liter.

November 9, 2023

BSK Associates Engineers & Laboratories

Description : B-1 @ 20'
Project : AGK0331

Lab ID : SP 2318473-001
Customer : 2022939

Sampled By : Darren Ferrer
Matrix : Ground Water

Micro Irrigation System Plugging Hazard

Test Description	Result		Graphical Results Presentation
Chemical			Slight / Moderate / Severe
Manganese	<0.01	mg/L	
Iron	<0.03	mg/L	
TDS by Summation	1070	mg/L	
No Amendments			
pH	8.3	units	
Alkalinity (As CaCO3)	150	mg/L	
Total Hardness	352	mg/L	
With Amendments			
Alkalinity (As CaCO3)	30	mg/L	
Total Hardness	30	mg/L	
pH	5.4 - 6.7	units	



Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

Water Amendments Application Notes:
The Amendments recommended on the previous pages include:

Gypsum:
This should be applied at least once a year to the irrigated soil surface area. Gypsum can also be applied in smaller quantities in the irrigation water.Apply the smaller (bracketed) amount of gypsum when also applying the recommended amount of Sulfuric Acid and the larger amount when applying only Gypsum.

Sulfuric Acid:
These products should be applied as needed to prevent emitter plugging in micro irrigation systems and/or as a soil amendment to adjust soil pH to improve nutrient availability and to facilitate leaching of salts. Please exercise caution when using this material as excesses may be harmful to the system and/or the plants being irrigated. The reported Acid requirement is intended to remove approximately 80 % of the alkalinity. The final pH should range from 5.4 to 6.7. We recommend a field pH determination to confirm that the pH you designate is being achieved. This application is based upon the use of a 98% Sulfuric Acid product. The application of Urea Sulfuric Acid is based upon the use of a product that contains 15% Urea (1.89 lbs Nitrogen), 49% Sulfuric Acid and has a specific gravity of 1.52 at 68 °F.
Please contact us if you have any questions.

BRW:EHB

Reviewed and Approved By **Ben Waddell**
Digitally signed by Ben Waddell
Title: Director of Ag. Services
Date: 2023-11-09

November 9, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-3 @ 30'
Project : AGK0331

Lab ID : SP 2318473-002
Customer : 2022939

Sampled On : November 2, 2023
Sampled By : Darren Ferrer
Received On : November 3, 2023
Matrix : Ground Water

General Irrigation Suitability Analysis

Test Description	Result				Graphical Results Presentation				
Cations	mg/L	Meq/L	% Meq	Lbs/AF	Good	Possible Problem	Moderate Problem	Increasing Problem	Severe Problem
Calcium	236	12	16	640	**				
Magnesium	190	16	21	520	**				
Potassium	11	0.28	0	30	**				
Sodium	1040	45	62	2800					
Anions									
Carbonate	<10	0	0	0					
Bicarbonate	900	15	19	2400	**				
Sulfate	1760	37	46	4800	**				
Chloride	960	27	34	2600					
Nitrate	31.0	0.5	1	84					
Nitrate Nitrogen	7.0			19					
Fluoride	0.2	0.011	0	0.5					
Minor Elements									
Boron	8.9			24					
Copper	<0.01			0					
Iron	<0.03			0					
Manganese	0.040			0.11					
Zinc	<0.02			0					
TDS by Summation	5130			14000					
Other									
pH	7.82	units							
E. C.	6.78	dS/m							
SAR	12.2								
Crop Suitability									
No Amendments	Poor								
With Amendments	Poor								
Amendments									
Gypsum Requirement	3.8	Tons/AF							
Sulfuric Acid (98%)	51.0	oz/1000Gal			Or 120 oz/1000Gal of urea Sulfuric Acid(15/49)				
Leaching Requirement	94	%							

Good  Problem

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.
** Used in various calculations; mg/L = Milligrams Per Liter (ppm) meq/L = Milliequivalents Per Liter.

November 9, 2023

BSK Associates Engineers & Laboratories

Description : B-3 @ 30'
Project : AGK0331

Lab ID : SP 2318473-002
Customer : 2022939

Sampled By : Darren Ferrer
Matrix : Ground Water

Micro Irrigation System Plugging Hazard

Test Description	Result		Graphical Results Presentation
Chemical			Slight / Moderate / Severe
Manganese	0.04	mg/L	
Iron	<0.03	mg/L	
TDS by Summation	5130	mg/L	
No Amendments			
pH	7.82	units	
Alkalinity (As CaCO3)	730	mg/L	
Total Hardness	1370	mg/L	
With Amendments			
Alkalinity (As CaCO3)	150	mg/L	
Total Hardness	150	mg/L	
pH	5.4 - 6.7	units	



Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

Water Amendments Application Notes:
The Amendments recommended on the previous pages include:

Gypsum:
This should be applied at least once a year to the irrigated soil surface area. Gypsum can also be applied in smaller quantities in the irrigation water.Apply the smaller (bracketed) amount of gypsum when also applying the recommended amount of Sulfuric Acid and the larger amount when applying only Gypsum.

Sulfuric Acid:
These products should be applied as needed to prevent emitter plugging in micro irrigation systems and/or as a soil amendment to adjust soil pH to improve nutrient availability and to facilitate leaching of salts. Please exercise caution when using this material as excesses may be harmful to the system and/or the plants being irrigated. The reported Acid requirement is intended to remove approximately 80 % of the alkalinity. The final pH should range from 5.4 to 6.7. We recommend a field pH determination to confirm that the pH you designate is being achieved. This application is based upon the use of a 98% Sulfuric Acid product. The application of Urea Sulfuric Acid is based upon the use of a product that contains 15% Urea (1.89 lbs Nitrogen), 49% Sulfuric Acid and has a specific gravity of 1.52 at 68 °F.
Please contact us if you have any questions.

BRW:EHB

Reviewed and Approved By **Ben Waddell**
Digitally signed by Ben Waddell
Title: Director of Ag. Services
Date: 2023-11-09

November 9, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-5 @ 20'
Project : AGK0331

Lab ID : SP 2318473-003
Customer : 2022939

Sampled On : November 2, 2023
Sampled By : Darren Ferrer
Received On : November 3, 2023
Matrix : Ground Water

General Irrigation Suitability Analysis

Test Description	Result				Graphical Results Presentation				
Cations	mg/L	Meq/L	% Meq	Lbs/AF	Good	Possible Problem	Moderate Problem	Increasing Problem	Severe Problem
Calcium	123	6.1	12	330	**				
Magnesium	111	9.1	18	300	**				
Potassium	7	0.18	0	19	**				
Sodium	797	35	69	2200					
Anions									
Carbonate	<10	0	0	0					
Bicarbonate	400	6.6	15	1100	**				
Sulfate	926	19	45	2500	**				
Chloride	600	17	39	1600					
Nitrate	30.7	0.5	1	83					
Nitrate Nitrogen	6.9			19					
Fluoride	0.2	0.011	0	0.5					
Minor Elements									
Boron	5.0			14					
Copper	<0.01			0					
Iron	<0.03			0					
Manganese	<0.01			0					
Zinc	<0.02			0					
TDS by Summation	2990			8100					
Other									
pH	8.17	units							
E. C.	4.07	dS/m							
SAR	12.5								
Crop Suitability									
No Amendments	Poor								
With Amendments	Poor								
Amendments									
Gypsum Requirement	3.1	Tons/AF							
Sulfuric Acid (98%)	23.0	oz/1000Gal			Or 56 oz/1000Gal of urea Sulfuric Acid(15/49)				
Leaching Requirement	41	%							

Good — Problem

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.
** Used in various calculations; mg/L = Milligrams Per Liter (ppm) meq/L = Milliequivalents Per Liter.

November 9, 2023

BSK Associates Engineers & Laboratories

Description : B-5 @ 20'
Project : AGK0331

Lab ID : SP 2318473-003
Customer : 2022939

Sampled By : Darren Ferrer
Matrix : Ground Water

Micro Irrigation System Plugging Hazard

Test Description	Result		Graphical Results Presentation
Chemical			Slight / Moderate / Severe
Manganese	<0.01	mg/L	
Iron	<0.03	mg/L	
TDS by Summation	2990	mg/L	
No Amendments			
pH	8.17	units	
Alkalinity (As CaCO3)	330	mg/L	
Total Hardness	764	mg/L	
With Amendments			
Alkalinity (As CaCO3)	66	mg/L	
Total Hardness	66	mg/L	
pH	5.4 - 6.7	units	



Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

Water Amendments Application Notes:
The Amendments recommended on the previous pages include:

Gypsum:
This should be applied at least once a year to the irrigated soil surface area. Gypsum can also be applied in smaller quantities in the irrigation water.Apply the smaller (bracketed) amount of gypsum when also applying the recommended amount of Sulfuric Acid and the larger amount when applying only Gypsum.

Sulfuric Acid:
These products should be applied as needed to prevent emitter plugging in micro irrigation systems and/or as a soil amendment to adjust soil pH to improve nutrient availability and to facilitate leaching of salts. Please exercise caution when using this material as excesses may be harmful to the system and/or the plants being irrigated. The reported Acid requirement is intended to remove approximately 80 % of the alkalinity. The final pH should range from 5.4 to 6.7. We recommend a field pH determination to confirm that the pH you designate is being achieved. This application is based upon the use of a 98% Sulfuric Acid product. The application of Urea Sulfuric Acid is based upon the use of a product that contains 15% Urea (1.89 lbs Nitrogen), 49% Sulfuric Acid and has a specific gravity of 1.52 at 68 °F.
Please contact us if you have any questions.

BRW:EHB

Reviewed and Approved By **Ben Waddell**
Digitally signed by Ben Waddell
Title: Director of Ag. Services
Date: 2023-11-09

BSK ASSOCIATES

SUBCONTRACT ORDER

AGK0331

11/4/23

Lab filter for Dissolved metals please!

SENDING LABORATORY:

BSK Associates Laboratory Fresno
687 N. Laverne Avenue
Fresno, CA 93727
Phone: 559-497-2888
Fax: 559-485-6935
Project Manager: Elaine M. Phillips
E-mail: ephillips@bskassociates.com

RECEIVING LABORATORY:

FGL Environmental
P.O. Box 272 / 853 Corporation
Santa Paula, CA 93060
Phone :(805) 392-2000
Fax: (805) 525-4172
Turnaround (Days): 7
QC Deliverables: I Std III IV

Sample ID	Samp Desc			Sample Date
AGK0331-01	B-1 @ 20'	Client Matrix:	Ground Water	11/02/2023 09:00
		Sampled By:	Darren Ferrer	

Lab Matrix: Water

Analysis:

Alkalinity as CaCO3
Arsenic, CA DW ICPMS Dissolved
Boron, CA DW ICP Dissolved
Calcium, CA DW ICP Dissolved
Chloride
Copper, CA DW ICPMS Dissolved
EC, Conductivity
Fluoride, Wastewater
Iron, CA DW ICP Dissolved
Magnesium, CA DW ICP Dissolved
Manganese, CA DW ICP Dissolved
Nitrate-N
Nitrate-NO3
Percent Sodium
pH, Drinking and Wastewaters
Potassium, CA DW ICP Dissolved
Selenium, CA DW ICPMS Dissolved
Sodium Absorption Ratio
Sodium, CA DW ICP Dissolved
Sulfate
TDS, Total Dissolved Solids
Zinc, CA DW ICPMS Dissolved

RUSH
*Irrigation Suitability

AGK0331-02	B-3 @ 30'	Client Matrix:	Ground Water	11/02/2023 12:30
		Sampled By:	Darren Ferrer	

Lab Matrix: Water

Analysis:

Alkalinity as CaCO3
Arsenic, CA DW ICPMS Dissolved
Boron, CA DW ICP Dissolved
Calcium, CA DW ICP Dissolved
Chloride
Copper, CA DW ICPMS Dissolved
EC, Conductivity
Fluoride, Wastewater
Iron, CA DW ICP Dissolved
Magnesium, CA DW ICP Dissolved
Manganese, CA DW ICP Dissolved
Nitrate-N

ASSOCIATES

SUBCONTRACT ORDER

AGK0331

Sample ID	Samp Desc			Sample Date
	Nitrate-NO3			
	Percent Sodium			
	pH, Drinking and Wastewaters			
	Potassium, CA DW ICP Dissolved			
	Selenium, CA DW ICPMS Dissolved			
	Sodium Absorption Ratio			
	Sodium, CA DW ICP Dissolved			
	Sulfate			
	TDS, Total Dissolved Solids			
	Zinc, CA DW ICPMS Dissolved			
AGK0331-03	**B-5 @ 20'**	**Client Matrix:**	Ground Water	**11/02/2023 11:00**
		Sampled By:	Darren Ferrer	

Lab Matrix: Water

Analysis:

Alkalinity as CaCO3
Arsenic, CA DW ICPMS Dissolved
Boron, CA DW ICP Dissolved
Calcium, CA DW ICP Dissolved
Chloride
Copper, CA DW ICPMS Dissolved
EC, Conductivity
Fluoride, Wastewater
Iron, CA DW ICP Dissolved
Magnesium, CA DW ICP Dissolved
Manganese, CA DW ICP Dissolved
Nitrate-N
Nitrate-NO3
Percent Sodium
pH, Drinking and Wastewaters
Potassium, CA DW ICP Dissolved
Selenium, CA DW ICPMS Dissolved
Sodium Absorption Ratio
Sodium, CA DW ICP Dissolved
Sulfate
TDS, Total Dissolved Solids
Zinc, CA DW ICPMS Dissolved

RUSH

State Forms: **No** System Name: _____

11.2.23

Released By	Date	Received By	Date
	11/3/23 1110		11/3/23 1110
Released By	Date	Received By	Date

Condition Upon Receipt (Attach to COC) SP 2318473

Sample Receipt at SP:

1. Number of ice chests/packages received: **1**
2. Shipper tracking numbers _____
3. Were samples received in a chilled condition?
   Temps: **6** /_____/_____/_____/_____/_____/_____

4. Surface water (SWTR) bact samples: A sample that has a temperature upon receipt of >10C, whether iced or not, should be flagged unless the time since sample collection has been less than two hours.

5. Do the number of bottles received agree with the COC?	**Yes**	**No**	**N/A**
6. Verify sample date, time, sampler	**Yes**	**No**	**N/A**
7. Were the samples received intact? (i.e. no broken bottles, leaks, etc.)	**Yes**	**No**	
8. Were sample custody seals intact?	**Yes**	**No**	**N/A**

Sample Verification, Labeling and Distribution:

1. Were all requested analyses understood and acceptable?	**Yes**	**No**		
2. Did bottle labels correspond with the client's ID's?	**Yes**	**No**		
3. Were all bottles requiring sample preservation properly preserved? [Exception: Oil & Grease, VOA and CrVI verified in lab]	**Yes**	**No**	**N/A**	**FGL**
4. VOAs checked for Headspace?	**Yes**	**No**	**N/A**	
5. Were all analyses within holding times at time of receipt?	**Yes**	**No**		
6. Have rush or project due dates been checked and accepted?	**Yes**	**No**	**N/A**	

Include a copy of the COC for lab delivery. (Bacti. Inorganics and Radio)

Sample Receipt, Login and Verification completed by: Reviewed and Approved By **Inez Covarrubias** Digitally signed by Inez Covarrubias Title: Sample Receiving Date: 11/06/2023-09:28:45

Discrepency Documentation:

Any items above which are "No" or do not meet specifications (i.e. temps) must be resolved.

1. Person Contacted: _____ Phone Number: _____
   Initiated By: _____ Date: _____
   Problem:

   Resolution:

2. Person Contacted: _____ Phone Number: _____
   Initiated By: _____ Date: _____
   Problem:

   Resolution:

(2022939)
BSK Associates
SP 2318473
IV/CDA-11/06/2023-09:28:45

Case Narrative

Project and Report Details		Invoice Details	
Client:	BSK Associates - Fresno	**Invoice To:**	BSK Associates - Corporate
Report To:	Neva Popenoe	**Invoice Attn:**	BSK Associates-Corp
Project #:	G00001262	**Project PO#:**	-
Received:	11/03/2023 - 17:26		
Report Due:	11/20/2023		

Sample Receipt Conditions

Cooler: Default Cooler

Temperature on Receipt ºC: 0.9

Containers Intact
COC/Labels Agree
Preservation Confirmed
Received On Wet Ice
Sample(s) arrived at lab on same day sampled.
Packing Material - Other
Sample(s) were received in temperature range.
Initial receipt at BSK-FAL

Data Qualifiers

The following qualifiers have been applied to one or more analytical results:

None applied

Report Distribution

Recipient(s)	Report Format	CC:
Neva Popenoe	FINAL.RPT	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Sample ID: AGK0479-01
Sampled By: Jacob Leu
Sample Description: B-6 @ 25'

Sample Date - Time: 11/03/2023 - 11:00
Matrix: Ground Water
Sample Type: Grab

BSK Associates Laboratory Fresno

General Chemistry

Analyte	Method	Result	RL	Units	RL Mult	Batch	Prepared	Analyzed	Qual
Nitrate as N	EPA 300.0	**9.3**	1.2	mg/L	5	AGK0210	11/03/23 20:59	11/03/23	
Nitrate as NO3	EPA 300.0	**41**	5.0	mg/L	5	AGK0210	11/03/23 20:59	11/03/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Sample ID: AGK0479-01RE1
Sampled By: Jacob Leu
Sample Description: B-6 @ 25'

Sample Date - Time: 11/03/2023 - 11:00
Matrix: Ground Water
Sample Type: Grab

BSK Associates Laboratory Fresno

General Chemistry

Analyte	Method	Result	RL	Units	RL Mult	Batch	Prepared	Analyzed	Qual
Hexavalent Chromium - Dissolved (1)	EPA 218.6	**1.9**	0.050	ug/L	1	AGK0984	11/15/23	11/15/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Sample ID: AGK0479-02
Sampled By: Jacob Leu
Sample Description: B-7 @ 25'

Sample Date - Time: 11/03/2023 - 08:36
Matrix: Ground Water
Sample Type: Grab

BSK Associates Laboratory Fresno

General Chemistry

Analyte	Method	Result	RL	Units	RL Mult	Batch	Prepared	Analyzed	Qual
Hexavalent Chromium - Dissolved (1)	EPA 218.6	**0.61**	0.050	ug/L	1	AGK0921	11/14/23	11/14/23	
Nitrate as N	EPA 300.0	**6.2**	1.2	mg/L	5	AGK0210	11/03/23 20:43	11/03/23	
Nitrate as NO3	EPA 300.0	**28**	5.0	mg/L	5	AGK0210	11/03/23 20:43	11/03/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

BSK Associates Laboratory Fresno

General Chemistry Quality Control Report

Analyte	Result	RL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Date Analyzed	Qual
EPA 218.6 - Quality Control											
Batch: AGK0921										Prepared: 11/14/2023	
Prep Method: Method Specific Preparation										Analyst: CTD	
Blank (AGK0921-BLK1)											
Hexavalent Chromium - Dissolved (1)	ND	0.050	ug/L							11/14/23	
Blank Spike (AGK0921-BS1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	102	90-110			11/14/23	
Blank Spike Dup (AGK0921-BSD1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	101	90-110	1	10	11/14/23	
Matrix Spike (AGK0921-MS1), Source: AGK1519-01											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	99	90-110			11/14/23	
Matrix Spike Dup (AGK0921-MSD1), Source: AGK1519-01											
Hexavalent Chromium - Dissolved (1)	2.1	0.050	ug/L	2.0	ND	106	90-110	7	10	11/14/23	
EPA 218.6 - Quality Control											
Batch: AGK0984										Prepared: 11/15/2023	
Prep Method: Method Specific Preparation										Analyst: CTD	
Blank (AGK0984-BLK1)											
Hexavalent Chromium - Dissolved (1)	ND	0.050	ug/L							11/15/23	
Blank Spike (AGK0984-BS1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	101	90-110			11/15/23	
Blank Spike Dup (AGK0984-BSD1)											
Hexavalent Chromium - Dissolved (1)	2.0	0.050	ug/L	2.0	ND	102	90-110	1	10	11/15/23	
Matrix Spike (AGK0984-MS1), Source: AGK0479-01RE1											
Hexavalent Chromium - Dissolved (1)	3.8	0.050	ug/L	2.0	1.9	95	90-110			11/15/23	
Matrix Spike Dup (AGK0984-MSD1), Source: AGK0479-01RE1											
Hexavalent Chromium - Dissolved (1)	3.9	0.050	ug/L	2.0	1.9	99	90-110	2	10	11/15/23	
EPA 300.0 - Quality Control											
Batch: AGK0210										Prepared: 11/3/2023	
Prep Method: Method Specific Preparation										Analyst: IDM	
Blank (AGK0210-BLK1)											
Nitrate as N	ND	0.23	mg/L							11/03/23	
Nitrate as NO3	ND	1.0	mg/L							11/03/23	
Blank Spike (AGK0210-BS1)											
Nitrate as N	22	0.23	mg/L	23	ND	100	90-110			11/03/23	
Nitrate as NO3	100	1.0	mg/L	100	ND	100	90-110			11/03/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

BSK Associates Laboratory Fresno

General Chemistry Quality Control Report

Analyte	Result	RL	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Date Analyzed	Qual
EPA 300.0 - Quality Control											
Batch: AGK0210										Prepared: 11/3/2023	
Prep Method: Method Specific Preparation										Analyst: AAS	
Matrix Spike (AGK0210-MS1), Source: AGK0369-01											
Nitrate as N	11	0.23	mg/L	11	ND	100	80-120			11/03/23	
Nitrate as NO3	51	1.0	mg/L	50	ND	100	80-120			11/03/23	
Matrix Spike (AGK0210-MS2), Source: AGK0436-02											
Nitrate as N	18	0.23	mg/L	11	6.1	105	80-120			11/03/23	
Nitrate as NO3	80	1.0	mg/L	50	27	105	80-120			11/03/23	
Matrix Spike Dup (AGK0210-MSD1), Source: AGK0369-01											
Nitrate as N	12	0.23	mg/L	11	ND	101	80-120	1	20	11/03/23	
Nitrate as NO3	51	1.0	mg/L	50	ND	101	80-120	1	20	11/03/23	
Matrix Spike Dup (AGK0210-MSD2), Source: AGK0436-02											
Nitrate as N	18	0.23	mg/L	11	6.1	105	80-120	0	20	11/03/23	
Nitrate as NO3	80	1.0	mg/L	50	27	105	80-120	0	20	11/03/23	

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Notes:

- The Chain of Custody document and Sample Integrity Sheet are part of the analytical report.
- Any remaining sample(s) for testing will be disposed of according to BSK's sample retention policy unless other arrangements are made in advance.
- All positive results for EPA Methods 504.1 and 524.2 require the analysis of a Field Reagent Blank (FRB) to confirm that the results are not a contamination error from field sampling steps. If Field Reagent Blanks were not submitted with the samples, this method requirement has not been performed.
- Samples collected by BSK Analytical Laboratories were collected in accordance with the BSK Sampling and Collection Standard Operating Procedures.
- J-value is equivalent to DNQ (Detected, not quantified) which is a trace value. A trace value is an analyte detected between the MDL and the laboratory reporting limit. This result is of an unknown data quality and is only qualitative (estimated). Baseline noise, calibration curve extrapolation below the lowest calibrator, method blank detections, and integration artifacts can all produce apparent DNQ values, which contribute to the un-reliability of these values.
- (1) - Residual chlorine and pH analysis have a 15 minute holding time for both drinking and waste water samples as defined by the EPA and 40 CFR 136. Waste water and ground water (monitoring well) samples must be field filtered to meet the 15 minute holding time for dissolved metals.
- Field tests are outside the scope of laboratory accreditation and there is no certification available for field testing.
- Summations of analytes (i.e. Total Trihalomethanes) may appear to add individual amounts incorrectly, due to rounding of analyte values occurring before or after the total value is calculated, as well as rounding of the total value.
- RL Multiplier is the factor used to adjust the reporting limit (RL) due to variations in sample preparation procedures and dilutions required for matrix interferences.
- Due to the subjective nature of the Threshold Odor Method, all characterizations of the detected odor are the opinion of the panel of analysts. The characterizations can be found in Standard Methods 2170B Figure 2170:1.
- The MCLs provided in this report (if applicable) represent the primary MCLs for that analyte.
- (2) - Formerly known as Bis(2-Chloroisopropyl) ether.

Unless otherwise noted, TOC results by SM 5310C method do not include purgeable organic carbon, which is removed along with the inorganic carbon interference. The POC contribution to TOC is considered to be negligible.

The results in this report apply to the samples analyzed in accordance with the chain of custody document. This analytical report must be reproduced in its entirety.

Certificate of Analysis

Definitions

mg/L:	Milligrams/Liter (ppm)	MDL:	Method Detection Limit	MDA95:	Min. Detected Activity
mg/Kg:	Milligrams/Kilogram (ppm)	RL:	Reporting Limit: DL x Dilution	MPN:	Most Probable Number
µg/L:	Micrograms/Liter (ppb)	ND:	None Detected below MRL/MDL	CFU:	Colony Forming Unit
µg/Kg:	Micrograms/Kilogram (ppb)	pCi/L:	PicoCuries per Liter	Absent:	Less than 1 CFU/100mLs
%:	Percent	RL Mult:	RL Multiplier	Present:	1 or more CFU/100mLs
NR:	Non-Reportable	MCL:	Maximum Contaminant Limit	U:	The analyte was not detected at or above the reported sample quantitation limit.

Please see the individual Subcontract Lab's report for applicable certifications.

The following parameters are not available for certification through CA ELAP:

Odor Diisopropyl ether (DIPE) by EPA 524.2

The following parameters are calculated values and are outside the scope of our NELAP accreditation:

Total Nitrogen Aggressive Index Trivalent Chromium

BSK is not accredited under the NELAP program for the following additional parameters: **NA**

Certifications: **Please refer to our website for a copy of our Accredited Fields of Testing under each certification.**

Fresno

State of California - ELAP	1180	State of Hawaii	4021
Los Angeles CSD	9254479	NELAP certified	4021-022
State of Nevada	CA000792024-03	State of Oregon - NELAP	4021-022
EPA UCMR5	CA00079	State of Washington	C997-23

Sacramento

State of California - ELAP	1180-S1		

San Bernardino

State of California - ELAP	1180-S2	Los Angeles CSD	9254478
NELAP certified	4119-008	State of Oregon - NELAP	4119-008

Vancouver

NELAP certified	WA100008-016	State of Oregon - NELAP	WA100008-016
State of Washington	C824-23		

AGK0479 BSKAs2880 11/02/2023

BSK Associates SR-FL-0002-24

Sample Integrity

BSK Bottles: Yes No Page 1 of 1

COC Info						
Was temperature within range? Chemistry ≤ 6°C Micro < 8°C	Yes	No	NA	Were correct containers and preservatives received for the tests requested?	Yes	No	NA
If samples were taken today, is there evidence that chilling has begun?	Yes	No	NA	Bubbles Present VOAs (524.2/TTHM/TCP)? TB Received? (Check Method Below)	Yes Yes	No No	NA NA
Did all bottles arrive unbroken and intact?	Yes	No		Was a sufficient amount of sample received?	Yes	No	
Did all bottle labels agree with COC?	Yes	No		Do samples have a hold time <72 hours?	Yes	No	
Was sodium thiosulfate added to CN sample(s) until chlorine was no longer present?	Yes	NA		Was PM notified of discrepancies? PM: By/Time:	Yes	No	NA

Bottles Received (— means preservation/chlorine checks are either N/A or are performed in the lab)

250ml(A) 500ml(B) 1Liter(C) 40mlVOA(V) 125ml(D)	Checks*	Passed?	1	2			
Bacti $Na_2S_2O_3$	—	—					
None (P) White Cap	—	—	IC	IB	IC	B	
Cr6 (P) Lt. Green Label/Blue Cap $NH_4OH(NH_4)_2SO_4$ **DW**	Cl, pH > 8	P F					
Cr6 (P) Pink Label/Blue Cap $NH_4OH(NH_4)_2SO_4$ **WW**	pH 9.3-9.7	P F	IA		IA		
Cr6 (P) Black Label/Blue Cap $NH_4OH(NH_4)_2SO_4$ **7199** ***24 HOUR HOLD TIME***	pH 9.0-9.5	P F					
HNO_3 (P) Red Cap or HCl (P) Purple Cap/Lt. Blue Label	—	—					
H_2SO_4 (P) or (AG) Yellow Cap/Label	pH < 2	P F					
NaOH (P) Green Cap	Cl, pH >10	P F					
NaOH + ZnAc (P)	pH > 9	P F					
Dissolved Oxygen 300ml (g)	—	—					
None (AG) 608/8081/8082, 625, 632/8321, 8151, 8270	—	—					
HCl (AG) Lt. Blue Label O&G, Diesel, **TCP**	—	—					
Ascorbic, EDTA, KH_2Ct (AG) Pink Label 525	—	—					
Na_2SO_3 250mL (AG) Neon Green Label 515	—	—					
$Na_2S_2O_3$ 1 Liter (Brown P) 549	—	—					
$Na_2S_2O_3$ (AG) Blue Label 548, THM, 524	—	—					
$Na_2S_2O_3$ (CG) Blue Label 504, 505, 547	—	—					
$Na_2S_2O_3$ + MCAA (CG) Orange Label 531	pH < 3	P F					
NH_4Cl (AG) Purple Label 552	—	—					
EDA (P) or (AG) Brown Label DBPs	—	—					
HCL (CG) 524.2,BTEX,Gas, MTBE, 8260/624	—	—					
Buffer pH 4 (CG)	—	—					
H_3PO_4 (CG) Salmon Label	—	—					
Trizma – EPA 537.1 Light Blue Label **FB**	---	---					
Ammonia Acetate - EPA 533 Purple Label **FB**	---	---					
Bottled Water	—	—					
Asbestos 1L (P) w/ Foil / LL Metals Bottle	—	—					
Clear Glass	—	—					
OTHER:	—	—					

11/3/23

Split

	Container	Preservative	Lot #	Initials	Date/Time
S P					
S P					

Preservation Check
pH Lot # AG04945
Cl Lot # AG09232

Comments

*Preservation check completed by lab performing analysis.

✓ **Indicates Blanks Received**

504 ___ 524.2 ___ TTHM ___ 537/533 ___ TCP___

✓ **MS/MSD Received Method:** _____

Labeled by: **Labels Checked by:**

Scanned: _____ Rush/Short HT Page: _____ Time:_____

BSK ASSOCIATES
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(559) 497-2888 CA ELAP No. 1180
www.bskassociates.com

Turnaround Time Request
☒ Standard - 10 business days
☐ Rush (Surcharge may apply)
Date needed:

AGK0479 BSKAs2880 11/02/2023 7

Temp: 0.9 °C **Thermometer ID:** 77

*Required Fields

Company/Client Name*:	Report Attention*:	Invoice To*:	Phone*:	Fax:
BSK Associates - Fresno	Neva Popenoe Additional cc's:	BSK Associates - Corp PO#:	(559) 497-2880 E-mail*: npopenoe@bskassociates.com	

Address*:	City*:	State*:	Zip*:
691 N. Laverne Ave, Suite 101	Fresno	CA	93727

Project:	Project #:	Phase #	Task #:
Los Banos Santa Fe Grade Basin	G00001262		

Reporting Options: ☐ Trace (J-Flag) ☐ Swamp ☐ EDD Type: _____

Sampler Name (Printed/Signature)*:

Regulatory Carbon Copies: ☐ SWRCB (Drinking Water) ☐ Merced Co ☐ Fresno Co ☐ Madera Co ☐ Tulare Co ☐ Other: _____

Regulatory Compliance: ☐ EDT to California SWRCB (Drinking Water) System Number*: _____ ☐ Geotracker #: _____

Matrix Types: SW=Surface Water BW=Bottled Water GW=Ground Water WW=Waste Water STW=Storm Water DW=Drinking Water SO=Solid

#	Sample Description*	Sampled* Date	Sampled* Time	Matrix*	Comments / Station Code / WTRAX	Irrigation Water, Ag Suitability Dissolved	Dissolved: As, Se	Hex Chrom 218.6 Dissolved	SAR Pkg
				GW	Lab filter for dissolved metals	X	X	X	X
	B-6 @ 25'	11/3	11:00	GW		X	X	X	X
	B-7 @ 25'	11/3	8:36	GW		X	X	X	X

11/3/23

Relinquished by: (Signature and Printed Name)	Company	Date	Time	Received by: (Signature and Printed Name)	Company
Relinquished by: (Signature and Printed Name) Jacob Lee	Company BSK	Date 11/3	Time 17:26	Received by: (Signature and Printed Name)	Company
Received for Lab by: (Signature and Printed Name) Joel Gorgin		Date 11/3/23	Time 1724	Payment Received at Delivery: Date: Amount: PIA#:	Check / Cash Init.

Shipping Method: GLS UPS ~~WALK-IN~~ FED EX PMS Courier: _____
Cooling Method: ~~Wet~~ Blue None

Custody Seal: Y / N
Chilling Process Begun: Y / N

Payment for services rendered as noted herein are due in full within 30 days from the date invoiced. If not so paid, account balances are deemed delinquent. Delinquent balances are subject to monthly service charges and interest specified in BSK's current Standard Terms and Conditions for Laboratory Services. The person signing for the Client/Company acknowledges that they are either the Client or an authorized agent to the Client, that the Client agrees to be responsible for payment for the services on this Chain of Custody, and agrees to BSK's terms and conditions for laboratory services unless contractually bound otherwise. BSK's current terms and conditions can be found at www.bskassociates.com/BSKLabTermsConditions.pdf

November 13, 2023

Lab No. : SP 2318633
Customer No. : 2022939

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Laboratory Report

Introduction: This report package contains a total of 7 pages divided into 3 sections:

Case Narrative	(2 pages)	: An overview of the work performed at FGL.
Sample Results	(2 pages)	: Results for each sample submitted.
Quality Control	(3 pages)	: Supporting Quality Control (QC) results.

Case Narrative

This Case Narrative pertains to the following samples:

Sample Description	Date Sampled	Date Received	FGL Lab No.	Matrix
B-6 @ 25'	11/03/2023	11/07/2023	SP 2318633-001	GW
B-7 @ 25'	11/03/2023	11/07/2023	SP 2318633-002	GW

Sampling and Receipt Information:

All samples were received in acceptable condition and within temperature requirements, unless noted on the Condition Upon Receipt (CUR) form. All samples were received, prepared and analyzed within the method specified holding times except those as listed in the table below. All samples arrived at 6 ° C. All samples were checked for pH if acid or base preservation is required (except for VOAs). For details of sample receipt information, please see the associated Chain of Custody and Condition Upon Receipt Form.

Samples Over Hold Time

Lab No	Analyte Method	Maximum Hold Time	Actual Hold Time
SP 2318633-001	Nitrate	48 hours	97.3 hours
SP 2318633-001	Nitrate Nitrogen	48 hours	97.3 hours
SP 2318633-001	pH	15 minutes	12,131.0 minutes
SP 2318633-002	Nitrate	48 hours	99.7 hours
SP 2318633-002	Nitrate Nitrogen	48 hours	99.7 hours
SP 2318633-002	pH	15 minutes	12,275.0 minutes

Quality Control: All samples were prepared and analyzed according to established quality control criteria. Any exceptions are noted in the Quality Control Section of this report.

Test Summary	
EPA 200.7	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
EPA 200.8	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
EPA 300.0	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
SM 2540 C	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)
SM 4500-H+B	Preparation and analysis performed by FGL-Santa Paula (FGL-SP ELAP# 1573)

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Certification: I certify that this data package is in compliance with ELAP standards, both technically and for completeness, except for any conditions listed above and in the QC Section. Release of the data contained in this data package is authorized by the Laboratory Director or his designee, as verified by the following electronic signature. This report shall not be reproduced except in full, without the written approval of the laboratory.

KD: MKH

Approved By **Kelly A. Dunnahoo, B.S.** Digitally signed by Kelly A. Dunnahoo, B.S.
Title: Laboratory Director
Date: 2023-11-13

Page 2 of 7

November 13, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-6 @ 25'
Project : AGK0479

Lab No. : SP 2318633-001
Customer No. : 2022939

Sampled On : November 3, 2023 at 11:00
Sampled By : Jacob Leu
Received On : November 7, 2023 at 11:30
Matrix : Ground Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
Irrigation Suit							Date	Time	Who	Method	Date	Time	Who
Total Hardness as CaCO3	872	2.5	mg/L		1		11/09/2023	06:00	ac	Calc.	11/09/2023	10:09	ac
Calcium	163	1	mg/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:09	ac
Magnesium	113	1	mg/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:09	ac
Potassium	5	1	mg/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:09	ac
Sodium	644	5*	mg/L		5		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	11:28	ac
Total Cations	45.6	---	meq/L		1		11/09/2023	06:00	ac	Calc.	11/09/2023	10:09	ac
Boron	4.2	0.1	mg/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:09	ac
Copper	ND	10	ug/L		1	U	11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:09	ac
Iron	ND	30	ug/L		1	U	11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:09	ac
Manganese	380	10	ug/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:09	ac
Zinc	ND	20	ug/L		1	U	11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:09	ac
Gypsum Requirement	2.2	0.01	Tons/AF		1		11/09/2023	06:00	ac	Calc.	11/09/2023	10:09	ac
SAR	9.5	0.1	--		1		11/09/2023	06:00	ac	Calc.	11/09/2023	10:09	ac
Total Alkalinity	410	10	mg/L		1		11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	10:56	amm
Hydroxide	ND	10	mg/L		1	U	11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	10:56	amm
Carbonate	ND	10	mg/L		1	U	11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	10:56	amm
Bicarbonate	500	10	mg/L		1		11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	10:56	amm
Sulfate	902	6.5*	mg/L		10		11/07/2023	12:16	ldm	EPA 300.0	11/08/2023	00:00	ldm
Chloride	580	13*	mg/L		10		11/07/2023	12:16	ldm	EPA 300.0	11/08/2023	00:00	ldm
Nitrate	48.8	0.4	mg/L		1	Th	11/07/2023	12:16	ldm	EPA 300.0	11/07/2023	19:41	ldm
Nitrate Nitrogen	11.0	0.1	mg/L		1	Th	11/07/2023	12:16	ldm	EPA 300.0	11/07/2023	19:41	ldm
Fluoride	0.2	0.1	mg/L		1		11/07/2023	12:16	ldm	EPA 300.0	11/07/2023	19:41	ldm
Total Anions	44.1	---	meq/L		1	h	11/11/2023	21:11	amm	Calc.	11/12/2023	10:56	amm
pH	8.02	---	units		1	T	11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	10:56	amm
E. C.	4130	1	umhos/cm		1		11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	10:56	amm
TDS by Summation	2960	0	mg/L		1	h	11/09/2023	06:00	ac	Calc.	11/09/2023	10:09	ac
Metals, Diss													
Arsenic	5	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/10/2023	14:28	ac
Selenium	13	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/09/2023	12:07	ac
Wet Chemistry													
Total Dissolved Solids (TFR)	3030	20	mg/L		1		11/09/2023	11:45	ctl	SM 2540 C	11/10/2023	11:00	ctl

DQF Flags Definition:
U Constituent results were non-detect.
T Exceeded method/regulatory-specific holding time.
h The MS/MSD did not meet QC criteria.

ND=Non-Detected, RL=Reporting Level * RL adjusted for dilution, Dil.=Dilution

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November 13, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-7 @ 25'
Project : AGK0479

Lab No. : SP 2318633-002
Customer No. : 2022939

Sampled On : November 3, 2023 at 08:36
Sampled By : Jacob Leu
Received On : November 7, 2023 at 11:30
Matrix : Ground Water

Sample Results - Inorganic

Constituent	Result	RL	Units	Note	Dil.	DQF	Sample Preparation			Sample Analysis			
Irrigation Suit							Date	Time	Who	Method	Date	Time	Who
Total Hardness as CaCO3	658	2.5	mg/L		1		11/09/2023	06:00	ac	Calc.	11/09/2023	10:16	ac
Calcium	130	1	mg/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:16	ac
Magnesium	81	1	mg/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:16	ac
Potassium	4	1	mg/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:16	ac
Sodium	589	5*	mg/L		5		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	11:35	ac
Total Cations	38.9	---	meq/L		1		11/09/2023	06:00	ac	Calc.	11/09/2023	10:16	ac
Boron	3.8	0.1	mg/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:16	ac
Copper	ND	10	ug/L		1	U	11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:16	ac
Iron	ND	30	ug/L		1	U	11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:16	ac
Manganese	350	10	ug/L		1		11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:16	ac
Zinc	ND	20	ug/L		1	U	11/09/2023	06:00	ac	EPA 200.7	11/09/2023	10:16	ac
Gypsum Requirement	2.5	0.01	Tons/AF		1		11/09/2023	06:00	ac	Calc.	11/09/2023	10:16	ac
SAR	10	0.1	--		1		11/09/2023	06:00	ac	Calc.	11/09/2023	10:16	ac
Total Alkalinity	440	10	mg/L		1		11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	11:09	amm
Hydroxide	ND	10	mg/L		1	U	11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	11:09	amm
Carbonate	ND	10	mg/L		1	U	11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	11:09	amm
Bicarbonate	530	10	mg/L		1		11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	11:09	amm
Sulfate	773	5*	mg/L		10		11/07/2023	12:16	ldm	EPA 300.0	11/08/2023	01:00	ldm
Chloride	470	10*	mg/L		10		11/07/2023	12:16	ldm	EPA 300.0	11/08/2023	01:00	ldm
Nitrate	33.8	0.4	mg/L		1	Th	11/07/2023	12:16	ldm	EPA 300.0	11/07/2023	20:01	ldm
Nitrate Nitrogen	7.6	0.1	mg/L		1	Th	11/07/2023	12:16	ldm	EPA 300.0	11/07/2023	20:01	ldm
Fluoride	0.1	0.1	mg/L		1		11/07/2023	12:16	ldm	EPA 300.0	11/07/2023	20:01	ldm
Total Anions	38.6	---	meq/L		1	h	11/11/2023	21:11	amm	Calc.	11/12/2023	11:09	amm
pH	8.08	---	units		1	T	11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	11:09	amm
E. C.	3530	1	umhos/cm		1		11/11/2023	21:11	amm	SM 4500-H+B	11/12/2023	11:09	amm
TDS by Summation	2610	0	mg/L		1	h	11/09/2023	06:00	ac	Calc.	11/09/2023	10:16	ac
Metals, Diss													
Arsenic	7	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/10/2023	14:34	ac
Selenium	10	1	ug/L		1	h	11/09/2023	10:00	ac	EPA 200.8	11/09/2023	12:14	ac
Wet Chemistry													
Total Dissolved Solids (TFR)	2320	20	mg/L		1		11/09/2023	11:45	ctl	SM 2540 C	11/10/2023	11:00	ctl

DQF Flags Definition:
U Constituent results were non-detect.
T Exceeded method/regulatory-specific holding time.
h The MS/MSD did not meet QC criteria.

ND=Non-Detected, RL=Reporting Level * RL adjusted for dilution, Dil.=Dilution

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November 13, 2023
BSK Associates

Lab No. : SP 2318633
Customer No. : 2022939

Quality Control - Metals

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Metals								
Boron	200.7	11/09/2023:212718AC	MS	mg/L	4.000	95.7%	75-125	
		(SP 2318807-001)	MSD	mg/L	4.000	93.5%	75-125	
			MSRPD	mg/L		1.6%	≤20.0	
Calcium	200.7	11/09/2023:212718AC	MS	mg/L	12.00	59.9%	<¼	406
		(SP 2318807-001)	MSD	mg/L	12.00	36.0%	<1/4	
			MSRPD	mg/L		1.6%	≤20.0	
Copper	200.7	11/09/2023:212718AC	MS	ug/L	800.0	123%	75-125	
		(SP 2318807-001)	MSD	ug/L	800.0	121%	75-125	
			MSRPD	ug/L		1.3%	≤20.0	
Iron	200.7	11/09/2023:212718AC	MS	ug/L	4000	92.8%	75-125	
		(SP 2318807-001)	MSD	ug/L	4000	89.7%	75-125	
			MSRPD	ug/L		3.4%	≤20.0	
Magnesium	200.7	11/09/2023:212718AC	MS	mg/L	12.00	83.9%	75-125	
		(SP 2318807-001)	MSD	mg/L	12.00	76.2%	75-125	
			MSRPD	mg/L		1.5%	≤20.0	
Manganese	200.7	11/09/2023:212718AC	MS	ug/L	800.0	98.4%	75-125	
		(SP 2318807-001)	MSD	ug/L	800.0	95.5%	75-125	
			MSRPD	ug/L		3.0%	≤20.0	
Potassium	200.7	11/09/2023:212718AC	MS	mg/L	12.00	100%	75-125	
		(SP 2318807-001)	MSD	mg/L	12.00	97.9%	75-125	
			MSRPD	mg/L		1.8%	≤20.0	
Sodium	200.7	11/09/2023:212718AC	MS	mg/L	12.00	70.3%	<¼	406
		(SP 2318807-001)	MSD	mg/L	12.00	42.5%	<1/4	
			MSRPD	mg/L		1.6%	≤20.0	
Zinc	200.7	11/09/2023:212718AC	MS	ug/L	800.0	103%	75-125	
		(SP 2318807-001)	MSD	ug/L	800.0	101%	75-125	
			MSRPD	ug/L		1.5%	≤20.0	
Arsenic	200.8	11/09/2023:212732AC	MS	ug/L	5.000	553%	75-125	435
		(CH 2379204-001)	MSD	ug/L	5.000	638%	75-125	435
			MSRPD	ug/L		14.2%	≤20	
Selenium	200.8	11/09/2023:212732AC	MS	ug/L	5.000	578%	75-125	435
		(CH 2379204-001)	MSD	ug/L	5.000	603%	75-125	435
			MSRPD	ug/L		4.2%	≤20	

Definition

DQO : Data Quality Objective - This is the criteria against which the quality control data is compared.

MS : Matrix Spikes - A random sample is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.

MSD : Matrix Spike Duplicate of MS/MSD pair - A random sample duplicate is spiked with a known amount of analyted. The recoveries are an indication of how that sample matrix affects analyte recovery.

MSRPD : MS/MSD Relative Percent Difference (RPD) - The MS relative percent difference is an indication of precision for the preparation and analysis.

ND : Non-detect - Result was below the DQO listed for the analyte.

Explanation

406 : Matrix Spike (MS) not within the Acceptance Range (AR) because of high analyte concentration in the sample. Data was accepted based on the LCS or CCV recovery.

435 : Sample matrix may be affecting this analyte. Data was accepted based on the LCS or CCV recovery.

Corporate Offices & Laboratory
853 Corporation Street
Santa Paula, CA 93060
TEL: (805)392-2000
Env FAX: (805)525-4172 / Ag FAX: (805)392-2063
CA ELAP Certification No. 1573

Office & Laboratory
2500 Stagecoach Road
Stockton, CA 95215
TEL: (209)942-0182
FAX: (209)942-0423
CA ELAP Certification No. 1563

Office & Laboratory
563 E. Lindo Avenue
Chico, CA 95926
TEL: (530)343-5818
FAX: (530)343-3807
CA ELAP Certification No. 2670

Office & Laboratory
3442 Empresa Drive, Suite D
San Luis Obispo, CA 93401
TEL: (805)783-2940
FAX: (805)783-2912
CA ELAP Certification No. 2775

Office & Laboratory
9415 W. Goshen Avenue
Visalia, CA 93291
TEL: (559)734-9473
FAX: (559)734-8435
CA ELAP Certification No. 2810

November 13, 2023
BSK Associates

Lab No. : SP 2318633
Customer No. : 2022939

Quality Control - Wet Chem

Constituent	Method	Date/ID	Type	Units	Conc.	QC Data	DQO	Note
Wet Chem								
Alkalinity (as CaCO3)	2320B	11/11/2023:212846AMM	ND	mg/L		0.06%	10	435
Bicarbonate	2320B	(SP 2318735-002)	Dup	mg/L		0.1%	10	
E. C.	2320B	(SP 2318735-002)	Dup	umhos/cm		0.2%	5	
pH	2320B	(SP 2318735-002)	Dup	units		0.1%	4.80	
Solids, Total Dissolved	2540CE	11/09/2023:212748CTL	Blank	mg/L		ND	<20	
			LCS	mg/L	991.5	101%	90-110	
		(SP 2318698-001)	Dup	mg/L		0.2%	5	
		(SP 2318698-001)	Dup	mg/L		1.16%	5	
Chloride	300.0	11/07/2023:212665LDM	Blank	mg/L		ND	<1	
			LCS	mg/L	25.00	101%	90-110	
			MS	mg/L	50.00	89.7%	67-117	
		(SP 2318353-002)	MSD	mg/L	50.00	90.2%	67-117	
			MSRPD	mg/L		0.3%	≤7	
			MS	mg/L	50.00	90.7%	67-117	
		(CC 2383822-005)	MSD	mg/L	50.00	91.1%	67-117	
			MSRPD	mg/L		0.2%	≤7	
Fluoride	300.0	11/07/2023:212665LDM	Blank	mg/L		ND	<0.1	
			LCS	mg/L	2.500	101%	90-110	
			MS	mg/L	5.000	108%	89-111	
		(SP 2318353-002)	MSD	mg/L	5.000	109%	89-111	
			MSRPD	mg/L		1.3%	≤9	
			MS	mg/L	5.000	104%	89-111	
		(CC 2383822-005)	MSD	mg/L	5.000	104%	89-111	
			MSRPD	mg/L		0.2%	≤9	
Nitrate	300.0	11/07/2023:212665LDM	Blank	mg/L		ND	<0.4	
			LCS	mg/L	20.00	99.6%	90-110	
			MS	mg/L	40.00	113%	86-112	435
		(SP 2318353-002)	MSD	mg/L	40.00	113%	86-112	435
			MSRPD	mg/L		0.4%	≤7	
			MS	mg/L	40.00	103%	86-112	
		(CC 2383822-005)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.1%	≤7	
Nitrate Nitrogen	300.0	11/07/2023:212665LDM	Blank	mg/L		ND	<0.4	
			LCS	mg/L	20.00	99.6%	90-110	
			MS	mg/L	40.00	113%	86-112	435
		(SP 2318353-002)	MSD	mg/L	40.00	113%	86-112	435
			MSRPD	mg/L		0.4%	≤7	
			MS	mg/L	40.00	103%	86-112	
		(CC 2383822-005)	MSD	mg/L	40.00	103%	86-112	
			MSRPD	mg/L		0.1%	≤7	
Sulfate	300.0	11/07/2023:212665LDM	Blank	mg/L		ND	<0.5	
			LCS	mg/L	50.00	102%	90-110	
			MS	mg/L	100.0	94.2%	18-165	
		(SP 2318353-002)	MSD	mg/L	100.0	94.3%	18-165	
			MSRPD	mg/L		0.1%	≤7	
			MS	mg/L	100.0	104%	18-165	
		(CC 2383822-005)	MSD	mg/L	100.0	105%	18-165	
			MSRPD	mg/L		0.2%	≤7	

Page 6 of 7

Definition

Blank	:	Method Blank - Prepared to verify that the preparation process is not contributing contamination to the samples.
Dup	:	Duplicate Sample - A random sample with each batch is prepared and analyzed in duplicate. The relative percent difference is an indication of precision for the preparation and analysis.
LCS	:	Laboratory Control Standard/Sample - Prepared to verify that the preparation process is not affecting analyte recovery.
MS	:	Matrix Spikes - A random sample is spiked with a known amount of analyte. The recoveries are an indication of how that sample matrix affects analyte recovery.
MSD	:	Matrix Spike Duplicate of MS/MSD pair - A random sample duplicate is spiked with a known amount of analyted. The recoveries are an indication of how that sample matrix affects analyte recovery.
MSRPD	:	MS/MSD Relative Percent Difference (RPD) - The MS relative percent difference is an indication of precision for the preparation and analysis.
ND	:	Non-detect - Result was below the DQO listed for the analyte.

Explanation

435	:	Sample matrix may be affecting this analyte. Data was accepted based on the LCS or CCV recovery.

Page 7 of 7

November 13, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-6 @ 25'
Project : AGK0479

Lab ID : SP 2318633-001
Customer : 2022939

Sampled On : November 3, 2023
Sampled By : Jacob Leu
Received On : November 7, 2023
Matrix : Ground Water

General Irrigation Suitability Analysis

Test Description	Result				Graphical Results Presentation				
Cations	mg/L	Meq/L	% Meq	Lbs/AF	Good	Possible Problem	Moderate Problem	Increasing Problem	Severe Problem
Calcium	163	8.1	18	440	**				
Magnesium	113	9.3	20	310	**				
Potassium	5	0.13	0	14	**				
Sodium	644	28	61	1800					
Anions									
Carbonate	<10	0	0	0					
Bicarbonate	500	8.2	19	1400	**				
Sulfate	902	19	43	2500	**				
Chloride	580	16	37	1600					
Nitrate	48.8	0.79	2	130					
Nitrate Nitrogen	11.0			30					
Fluoride	0.2	0.011	0	0.5					
Minor Elements									
Boron	4.2			11					
Copper	<0.01			0					
Iron	<0.03			0					
Manganese	0.38			1					
Zinc	<0.02			0					
TDS by Summation	2960			8000					
Other									
pH	8.02	units							
E. C.	4.13	dS/m							
SAR	9.50								
Crop Suitability									
No Amendments	Poor								
With Amendments	Poor								
Amendments									
Gypsum Requirement	2.2	Tons/AF							
Sulfuric Acid (98%)	29.0	oz/1000Gal			Or 69 oz/1000Gal of urea Sulfuric Acid(15/49)				
Leaching Requirement	42	%							

Good — Problem

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.
** Used in various calculations; mg/L = Milligrams Per Liter (ppm) meq/L = Milliequivalents Per Liter.

November 13, 2023

BSK Associates Engineers & Laboratories

Description : B-6 @ 25'
Project : AGK0479

Lab ID : SP 2318633-001
Customer : 2022939

Sampled By : Jacob Leu
Matrix : Ground Water

Micro Irrigation System Plugging Hazard

Test Description	Result		Graphical Results Presentation
Chemical			Slight / Moderate / Severe
Manganese	0.38	mg/L	
Iron	<0.03	mg/L	
TDS by Summation	2960	mg/L	
No Amendments			
pH	8.02	units	
Alkalinity (As CaCO3)	410	mg/L	
Total Hardness	872	mg/L	
With Amendments			
Alkalinity (As CaCO3)	82	mg/L	
Total Hardness	82	mg/L	
pH	5.4 - 6.7	units	



Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

Water Amendments Application Notes:
The Amendments recommended on the previous pages include:

Gypsum:
This should be applied at least once a year to the irrigated soil surface area. Gypsum can also be applied in smaller quantities in the irrigation water.Apply the smaller (bracketed) amount of gypsum when also applying the recommended amount of Sulfuric Acid and the larger amount when applying only Gypsum.

Sulfuric Acid:
These products should be applied as needed to prevent emitter plugging in micro irrigation systems and/or as a soil amendment to adjust soil pH to improve nutrient availability and to facilitate leaching of salts. Please exercise caution when using this material as excesses may be harmful to the system and/or the plants being irrigated. The reported Acid requirement is intended to remove approximately 80 % of the alkalinity. The final pH should range from 5.4 to 6.7. We recommend a field pH determination to confirm that the pH you designate is being achieved. This application is based upon the use of a 98% Sulfuric Acid product. The application of Urea Sulfuric Acid is based upon the use of a product that contains 15% Urea (1.89 lbs Nitrogen), 49% Sulfuric Acid and has a specific gravity of 1.52 at 68 °F.
Please contact us if you have any questions.

BRW:EHB

Reviewed and Approved By **Ben Waddell**
Digitally signed by Ben Waddell
Title: Director of Ag. Services
Date: 2023-11-13

November 13, 2023

BSK Associates Engineers & Laboratories
687 N. Laverne Avenue
Fresno, CA 93727

Description : B-7 @ 25'
Project : AGK0479

Lab ID : SP 2318633-002
Customer : 2022939

Sampled On : November 3, 2023
Sampled By : Jacob Leu
Received On : November 7, 2023
Matrix : Ground Water

General Irrigation Suitability Analysis

Test Description	Result				Graphical Results Presentation				
Cations	mg/L	Meq/L	% Meq	Lbs/AF	Good	Possible Problem	Moderate Problem	Increasing Problem	Severe Problem
Calcium	130	6.5	17	350	**				
Magnesium	81	6.7	17	220	**				
Potassium	4	0.1	0	11	**				
Sodium	589	26	66	1600					
Anions									
Carbonate	<10	0	0	0					
Bicarbonate	530	8.7	23	1400	**				
Sulfate	773	16	42	2100	**				
Chloride	470	13	34	1300					
Nitrate	33.8	0.55	1	92					
Nitrate Nitrogen	7.6			21					
Fluoride	0.1	0.0053	0	0.3					
Minor Elements									
Boron	3.8			10					
Copper	<0.01			0					
Iron	<0.03			0					
Manganese	0.35			0.95					
Zinc	<0.02			0					
TDS by Summation	2610			7100					
Other									
pH	8.08	units							
E. C.	3.53	dS/m							
SAR	10.0								
Crop Suitability									
No Amendments	Poor								
With Amendments	Poor								
Amendments									
Gypsum Requirement	2.5	Tons/AF							
Sulfuric Acid (98%)	31.0	oz/1000Gal			Or 74 oz/1000Gal of urea Sulfuric Acid(15/49)				
Leaching Requirement	34	%							

Good — Problem

Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.
** Used in various calculations; mg/L = Milligrams Per Liter (ppm) meq/L = Milliequivalents Per Liter.

November 13, 2023

BSK Associates Engineers & Laboratories

Description : B-7 @ 25'
Project : AGK0479

Lab ID : SP 2318633-002
Customer : 2022939

Sampled By : Jacob Leu
Matrix : Ground Water

Micro Irrigation System Plugging Hazard

Test Description	Result		Graphical Results Presentation
Chemical			Slight / Moderate / Severe
Manganese	0.35	mg/L	
Iron	<0.03	mg/L	
TDS by Summation	2610	mg/L	
No Amendments			
pH	8.08	units	
Alkalinity (As CaCO3)	440	mg/L	
Total Hardness	658	mg/L	
With Amendments			
Alkalinity (As CaCO3)	88	mg/L	
Total Hardness	88	mg/L	
pH	5.4 - 6.7	units	



Note: Color coded bar graphs have been used to provide you with 'AT-A-GLANCE' interpretations.

Water Amendments Application Notes:
The Amendments recommended on the previous pages include:

Gypsum:
This should be applied at least once a year to the irrigated soil surface area. Gypsum can also be applied in smaller quantities in the irrigation water.Apply the smaller (bracketed) amount of gypsum when also applying the recommended amount of Sulfuric Acid and the larger amount when applying only Gypsum.

Sulfuric Acid:
These products should be applied as needed to prevent emitter plugging in micro irrigation systems and/or as a soil amendment to adjust soil pH to improve nutrient availability and to facilitate leaching of salts. Please exercise caution when using this material as excesses may be harmful to the system and/or the plants being irrigated. The reported Acid requirement is intended to remove approximately 80 % of the alkalinity. The final pH should range from 5.4 to 6.7. We recommend a field pH determination to confirm that the pH you designate is being achieved. This application is based upon the use of a 98% Sulfuric Acid product. The application of Urea Sulfuric Acid is based upon the use of a product that contains 15% Urea (1.89 lbs Nitrogen), 49% Sulfuric Acid and has a specific gravity of 1.52 at 68 °F.
Please contact us if you have any questions.

BRW:EHB

Reviewed and Approved By **Ben Waddell**
Digitally signed by Ben Waddell
Title: Director of Ag. Services
Date: 2023-11-13

BSK ASSOCIATES

SUBCONTRACT ORDER

AGK0479

318433

Lab filter for dissolved metals please

SENDING LABORATORY:

BSK Associates Laboratory Fresno
687 N. Laverne Avenue
Fresno, CA 93727
Phone: 559-497-2888
Fax: 559-485-6935
Project Manager: Elaine M. Phillips
E-mail: ephillips@bskassociates.com

RECEIVING LABORATORY:

FGL Environmental
P.O. Box 272 / 853 Corporation
Santa Paula, CA 93060
Phone :(805) 392-2000
Fax: (805) 525-4172
Turnaround (Days): 7
QC Deliverables: I Std III IV

Sample ID	Samp Desc			Sample Date
AGK0479-01	B-6 @ 25'	Client Matrix:	Ground Water	11/03/2023 11:00
		Sampled By:	Jacob Leu	

Lab Matrix: Water

Analysis: 1 L 4750

Alkalinity as CaCO3
Arsenic, CA DW ICPMS Dissolved
Boron, CA DW ICP Dissolved
Calcium, CA DW ICP Dissolved
Chloride
Copper, CA DW ICPMS Dissolved
EC, Conductivity
Fluoride, Wastewater
Iron, CA DW ICP Dissolved
Magnesium, CA DW ICP Dissolved
Manganese, CA DW ICP Dissolved
Percent Sodium
Potassium, CA DW ICP Dissolved
Selenium, CA DW ICPMS Dissolved
Sodium Absorption Ratio
Sodium, CA DW ICP Dissolved
Sulfate
TDS, Total Dissolved Solids
Zinc, CA DW ICPMS Dissolved

*Please analyzed both samples for Irrigation Suitability package.

BSK Analyzed Nitrate in house to meet Hold times. Will provide results for calculation.

RUSH

AGK0479-02	B-7 @ 25'	Client Matrix:	Ground Water	11/03/2023 08:36
		Sampled By:	Jacob Leu	

Lab Matrix: Water

Analysis:

Alkalinity as CaCO3
Arsenic, CA DW ICPMS Dissolved
Boron, CA DW ICP Dissolved
Calcium, CA DW ICP Dissolved
Chloride
Copper, CA DW ICPMS Dissolved
EC, Conductivity
Fluoride, Wastewater
Iron, CA DW ICP Dissolved
Magnesium, CA DW ICP Dissolved
Manganese, CA DW ICP Dissolved
Percent Sodium
Potassium, CA DW ICP Dissolved
Selenium, CA DW ICPMS Dissolved
Sodium Absorption Ratio

ESK ASSOCIATES

SUBCONTRACT ORDER

AGK0479

2318633

Sample ID	Samp Desc	Sample Date
	Sodium, CA DW ICP Dissolved	
	Sulfate	
	TDS, Total Dissolved Solids	
	Zinc, CA DW ICPMS Dissolved	

State Forms: **No** System Name: _____

RUSH

Released By 11.6.23 Date — Received By Date

Released By GU 11/7/23 1130 Date — Received By 11/7/23 1130 Date

Condition Upon Receipt (Attach to COC) SP 2318633

Sample Receipt at SP:

1. Number of ice chests/packages received: **1**
2. Shipper tracking numbers _____
3. Were samples received in a chilled condition?
   Temps: **6** /_____/_____/_____/_____/_____/_____/_____

4. Surface water (SWTR) bact samples: A sample that has a temperature upon receipt of >10C, whether iced or not, should be flagged unless the time since sample collection has been less than two hours.

5. Do the number of bottles received agree with the COC?	**Yes**	**No**	**N/A**
6. Verify sample date, time, sampler	**Yes**	**No**	**N/A**
7. Were the samples received intact? (i.e. no broken bottles, leaks, etc.)	**Yes**	**No**	
8. Were sample custody seals intact?	**Yes**	**No**	**N/A**

Sample Verification, Labeling and Distribution:

1. Were all requested analyses understood and acceptable?	**Yes**	**No**		
2. Did bottle labels correspond with the client's ID's?	**Yes**	**No**		
3. Were all bottles requiring sample preservation properly preserved? [Exception: Oil & Grease, VOA and CrVI verified in lab]	**Yes**	**No**	**N/A**	**FGL**
4. VOAs checked for Headspace?	**Yes**	**No**	**N/A**	
5. Were all analyses within holding times at time of receipt?	**Yes**	**No**		
6. Have rush or project due dates been checked and accepted?	**Yes**	**No**	**N/A**	

Include a copy of the COC for lab delivery. (Bacti. Inorganics and Radio)

Sample Receipt, Login and Verification completed by: Reviewed and Approved By **Inez Covarrubias** Digitally signed by Inez Covarrubias Title: Sample Receiving Date: 11/09/2023-11:17:14

Discrepency Documentation:

Any items above which are "No" or do not meet specifications (i.e. temps) must be resolved.

1. Person Contacted: _____ Phone Number: _____
   Initiated By: _____ Date: _____
   Problem:

   Resolution:

2. Person Contacted: _____ Phone Number: _____
   Initiated By: _____ Date: _____
   Problem:

   Resolution:

(2022939)
BSK Associates
SP 2318633
IV/CDA-11/09/2023-11:17:14

APPENDIX C

GEOTECHNICAL ENGINEERING INVESTIGATION ENTITLED, PROPOSED RECHARGE BASIN AND SEWER IMPROVEMENTS – NEW SIPHON BY BSK ASSOCIATES, DATED FEBRUARY 27TH, 2025.

691 N. Laverne Avenue, Suite 101
Fresno, CA 93727
P 559.497.2880
www.bskassociates.com

Sent via email: gheisdorf@ppeng.com

February 27, 2025 BSK Project G25000023

Ms. Gretchen Heisdorf
Provost & Pritchard Consulting Group
455 W. Fir Avenue
Clovis, California 93611

SUBJECT: **Geotechnical Engineering Report Update**
Proposed Recharge Basin and Sewer Improvements – New Siphon
Los Banos, California

Dear Ms. Heisdorf:

BSK Associates (BSK) is pleased to submit this letter/report for updated geotechnical engineering services for the proposed project in Los Banos, California. We prepared this report in response to request for information from the design team for the referenced project. A previous report was prepared by BSK for the subject project (BSK Project # G00001262, dated January 15, 2024).

BACKGROUND

We understand a siphon is planned to carry irrigation water from the San Luis Canal. There are two (2) existing sewer mains, and a proposed sewer main crossing the canal. The siphon is anticipated to be approximately 16 feet below adjacent ground surface.

UPDATED RECOMMENDATIONS

Additional Retaining Structure Recommendations

Lateral earth pressures presented in the referenced report represent pressures adjacent to native subsurface materials. If engineered fill is placed adjacent to proposed buried structures from a point starting at the bottom of the proposed retaining wall foundation to a point at a slope of 1H:1V (horizontal:vertical) from vertical to the ground surface, reduced lateral earth pressures may be considered. Lateral earth pressures for engineered fill are presented in the table below and are expressed as equivalent fluid pressures (unit weights) in units of pounds per cubic foot (pcf). In addition to these earth pressures, the designer should use the below design groundwater values unless a drainage system is installed behind the walls.

Table 1: Lateral Earth Pressures for Walls Backfilled with Engineered Fill[1]		
Lateral Pressure Conditions	**Equivalent Fluid Pressure (above design groundwater depth[2]) (pcf)**	**Equivalent Fluid Pressure (below design groundwater depth[3]) (pcf)**
Active Pressure	35	19 + hydrostatic
At-Rest Pressure	55	30 + hydrostatic
Dynamic Increment[4]	13.2H	13.2H

Notes:
1. Engineered fill must be placed from bottom of retaining wall footing and back at a 1H:1V (horizontal:vertical) angle from vertical
2. Design groundwater depth anticipated to be 20 feet below ground surface, based on referenced report
3. Or if wall is not provided with sufficient drainage system
4. H is wall height in feet

Parameters are shown in the above table for drained conditions of select engineered fill or prepared native soil. In addition, the drained condition assumes that positive drainage will be provided away from the structure improvements and that water does not accumulate around the structure and cause a build-up of hydrostatic pressure.

Based on the subsurface conditions encountered in our explorations, soldier piles may be considered for retaining structures. Table 7 of the referenced report may be used to design soldier pile shoring, if selected. Note that the values provided in Table 7 are provided with a factor of safety of 2.

Additional Site Preparation and Earthwork Construction Recommendations

In the area of the proposed siphon, and nearby excavations to exceed 6 feet in depth, overexcavation is not anticipated to be required, provided disturbed or loose soils are removed and recompacted. Bottom of excavations exceeding 6 feet in depth must be scarified a minimum of 8 inches, and recompacted to 90 percent relative compaction at least 2 percent over optimum moisture content for clayey soils and within 2 percent of optimum moisture content for granular soils based on ASTM D1557 (latest edition).

Additional Temporary Excavations Recommendations

Excavations should be properly dewatered as discussed in the “Dewatering” section below. Construction equipment and soil stockpiles should be set back a minimum horizontal distance of “H” away from the edge of excavations, where H is equal to the depth of the excavation. This setback distance also applies to shored excavations unless the shoring design takes into account any surcharge loads associated with the construction equipment and stockpiles.

During wet weather, appropriate provisions, such as the use of earthen berms, should be made to prevent water runoff from ponding adjacent to the top of excavations and/or flowing over the sides of the excavations, otherwise the excavations side walls and/or slopes could be compromised. All runoff

should be collected and disposed of outside the construction limits. Backfill for excavations should be compacted as noted in the referenced report. Special care should be taken in the control of excavation backfilling under structures and pavements. Poor compaction may cause excessive settlements resulting in damage to overlying structures and the pavement structural section.

Construction Considerations

Any ponding water must be pumped out of the exposed excavation prior to any backfill procedures.

Earthwork operations should be scheduled as to avoid working during periods of inclement weather. Should these operations be performed during or shortly following periods of inclement weather, unstable soil conditions may result in the soils exhibiting a "pumping" condition. This condition is caused by excess moisture, in combination with compaction, resulting in saturation and zero air voids in the soils.

If subgrade material starts to pump during compaction efforts, we recommend not using vibratory equipment. If pumping continues, overexcavate a minimum of 6 inches and replace with aggregate base, and recompact material. If pumping is overly excessive, overexcavate 1 foot, place Caltrans standard Filter Fabric nonwoven geotextile at the bottom of the excavation (such as Mirafi 140N, or equivalent), and backfill with 1-foot of aggregate base, as directed above. A representative must be present during compaction. Alternatively, consideration to subgrade improvements may include lime or cement treatment or the use of a biaxial geogrid with aggregate base.

PLANS AND SPECIFICATIONS REVIEW

BSK recommends that it be retained to review the draft plans and specifications for the project, prior to their being finalized.

CONSTRUCTION TESTING AND OBSERVATIONS

Geotechnical testing and observation during construction is a vital extension of this geotechnical investigation. BSK recommends that it be retained for those services. Field review during Site preparation and grading allows for evaluation of the exposed soil conditions and confirmation or revision of the assumptions and extrapolations made in formulating the design parameters and recommendations. BSK's observations must be supplemented with periodic compaction tests to establish substantial conformance with these recommendations. BSK must also be called to the Site to observe excavations, prior to placement of pavement, in order to assess whether the actual conditions are compatible with the conditions anticipated during the preparation of this report.

If a firm other than BSK is retained for these services during construction, then that firm must notify the owner, project designers, governmental building officials, and BSK that the firm has assumed the responsibility for all phases (i.e., both design and construction) of the project within the purview of the

geotechnical engineer. Notification must indicate that the firm has reviewed this report and any subsequent addenda, and that it either agrees with BSK's conclusions and recommendations, or that it will provide independent recommendations.

LIMITATIONS

The analyses and recommendations submitted in this report are based limited data. The report does not reflect variations which may occur between or beyond any Borings. The nature and extent of such variations may not become evident until construction is initiated. If variations then appear, a re-evaluation of the recommendations of this report will be necessary after performing on-Site observations during the excavation period and noting the characteristics of the variations.

The validity of the recommendations contained in this report is also dependent upon an adequate testing and observation program during the construction phase. BSK assumes no responsibility for construction compliance with the design concepts or recommendations unless it has been retained to perform the testing and observation services during construction as described above.

The findings of this report are valid as of the present. However, changes in the conditions of the Site can occur with the passage of time, whether caused by natural processes or the work of man, on this property or adjacent property. In addition, changes in applicable or appropriate standards may occur, whether they result from legislation, governmental policy or the broadening of knowledge.

BSK has prepared this report for the exclusive use of the Client and members of the project design team. The report has been prepared in accordance with generally accepted geotechnical engineering practices which existed in Merced County at the time the report was written. No other warranties either expressed or implied are made as to the professional advice provided under the terms of BSK's agreement with Client and included in this report.

If you have questions concerning this document or require additional information or services, please contact the undersigned at (559) 497-2880, extension 522, or npopenoe@bskassociates.com.

Respectfully submitted,

BSK Associates

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APPENDIX D

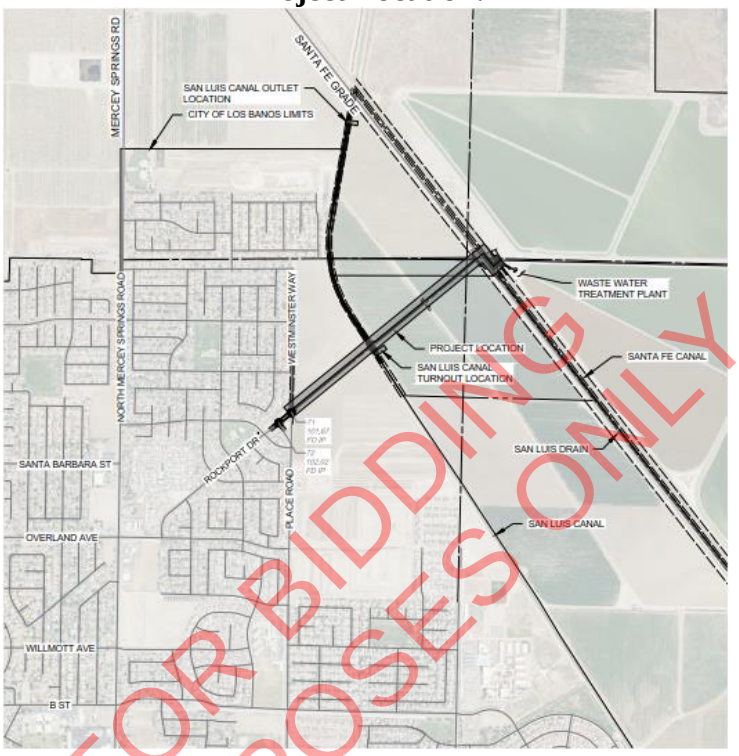
STORMWATER POLLUTION PREVENTION PLAN (BIDDING PURPOSES ONLY)

UNDER ONE ACRE POLLUTION PREVENTION PLAN

for

Serwer Pipeline Replacement

Project Location:



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Project Address:
Westminster Ave and Rockport Ave to City WWTP
37.078951, -120.826192 to 37.085105, -120.815413

Legally Responsible Person (LRP):
City of Los Banos
Charles Bergson
559-827-7056

Site Operating Hours:
Monday – Friday, 8:00 am – 5:00 pm

Estimated Project Dates:
Start of Construction: June 1, 2025
Completion of Construction: May 31, 2026

UPPP Prepared by:

Provost & Pritchard Consulting Group
455 W Fir Ave., Clovis, CA 93611
(559) 449-2700

UPPP Preparation Date:

February 2025

UPPP Developer's Name and Signature:

Gretchen Heisdorf

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Abbreviations

ac ..... acre
ac-ft ..... acre feet
bgs ..... below ground surface
BMP ..... Best Management Practice
CGP ..... Construction General Permit
CoC ..... Chain of Custody
CSMP ..... Construction Site Monitoring Plan
LRP ..... Legally Responsible Person
MS4 ..... Municipal Separate Storm Sewer System
msl ..... mean sea level
MSRP ..... Monitoring and Sampling Plan
NOAA ..... National Oceanic Atmospheric Administration
NPDES ..... National Pollutant Discharge Elimination System
NTU ..... Nephelometric Turbidity Units
QAPrP ..... Quality Assurance Program Plan
QA/QC ..... Quality Assurance and Quality Control
RWQCB ..... Regional Water Quality Control Board
SDS ..... Safety Data Sheets
SMARTS ..... Stormwater Multi Application and Report Tracking System
SWAMP ..... Surface Water Ambient Monitoring Program
SWPPP ..... Stormwater Pollution Prevention Plan
SWRCB ..... State Water Resources Control Board
USEPA ..... United States Environmental Protection Agency
UPPP ..... Under One Acre Pollution Prevention Plan
WDID ..... Waste Discharge Identification
WQO ..... Water Quality Order

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Section 1 UPPP Requirements

1.1 INTRODUCTION

This Under One Acre Pollution Prevention Plan (UPPP) is designed to comply with California's *CalGreen Building Code* and generally with the *General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (2022 CGP),* State Water Resources Control Board (State Water Board) *Order No. 2022-0057-DWQ (NPDES No. CAS000002).*This UPPP has been prepared following the 2022 CGP SWPPP Template for Traditional Projects provided in the California Stormwater Quality Association (CASQA) Stormwater *Best Management Practice (BMP) Handbook: Construction* (CASQA 2023).

This project is considered a traditional construction project.

This UPPP is designed to address the following:

- Identification of all pollutants, their sources, and control mechanisms, including sources of sediment associated with all construction activities (e.g., sediment, paint, cement, stucco, cleaners, site erosion);
- Pollutant source assessments, including a list of potential pollutant sources and identification of site areas where additional BMPs are necessary to reduce or prevent pollutants in stormwater and authorized non-stormwater discharges, per the minimum requirements when developing the pollutant source assessment;
- Description of site-specific BMPs implemented to reduce or eliminate stormwater pollution;
- Where not otherwise required to be under a Regional Water Quality Control Board (Regional Water Board) permit, all non-stormwater discharges are identified and either eliminated, controlled, or treated;
- Site BMPs are effective and result in the reduction or elimination of pollutants in stormwater discharges and authorized non-stormwater discharges from construction activity to the Best Available Technology/Best Control Technology (BAT/BCT) standard; and;
- Stabilization BMPs are installed to reduce or eliminate pollutants after construction is completed are effective and maintained; and
- Calculations and design details, as well as BMP controls, are complete and correct.

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The Sewer Replacement Pipeline Project (Project, or Site) will disturb less than 1-acre. The Project is located at the intersection of Westminster Ave & Rockport Ave to the City WWTP, in Los Banos, California. The project will be located in an existing City easement property. The project's location is shown on the Site Maps in Appendix A.

1.2 UPPP AVAILABILITY AND IMPLEMENTATION

The UPPP will be available at the construction site during working hours list on the title sheet and Section 5.3, while construction is occurring and shall be made available upon request by a federal, state, or municipal inspector. A current copy of the site-specific UPPP may be kept in electronic format at the site so long as the information requested by a federal, state, or municipal inspector can be made available during an inspection. Legible maps in hard copy must be available at the site. The SWPPP must be implemented at the appropriate level to protect water quality at all times throughout the life of the project.

Section 2 Project Information

2.1 PROJECT AND SITE DESCRIPTION

2.1.1 Site Description

The project site is less than 1 acre and is located at the intersection of Westminster Ave & Rockport Ave to the City WWTP, in Los Banos, California. The project site is located approximately 1.5 miles north of SR 152 and crosses two Grassland Water District canals and the USBR San Luis Drain. The project alignment is located from 37.078951, -120.826192 to 37.085105, -120.815413 and is identified on the Site Map in Appendix A.

2.1.2 Existing Conditions

As of the initial date of this SWPPP, the project site is open, undeveloped ag land and fields. There are no known historic sources of contamination.

2.1.3 Existing Drainage

The project site is relatively level. The surface elevation of the project site ranges from 100-105 feet above mean sea level (msl). Surface drainage at the site currently percolates into the ground.

2.1.4 Geology and Groundwater

According to the Geotechnical Engineering Investigation Report for the Proposed New Recharge Basin and Sewer Improvements, dated January 15, 2024;

> The near surface soil consisted of sandy clay, clayey sand and sandy silt, underlain by sandy silt, silty sand and poorly graded sand to the maximum depth explored (51.5 feet bgs)… The soil types encountered in the upper 10 to 20 feet were predominantly sandy silts and clays.

Additionally in the report,

> Groundwater was encountered as shallow as 20 feet…The California Department of Water Resources indicates the depth to recent regional groundwater at the project site is greater than 25 feet bgs. However, fluctuations in the groundwater level or the presence of perched groundwater may occur due to variations in rainfall, irrigation, seasonal factors, pumping from wells and other factors that were not evident at the time of our investigation. Groundwater is not anticipated to affect construction of the proposed improvements above 20 feet bgs.

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2.1.5 Project Description

Project grading will occur on less than 1 acre. The limits of grading are shown on Site Maps in Appendix A. Soil will be stockpiled adjacent to the pipe alignment as shown on Site Maps in Appendix A. Construction activities will be phased to complete work within the Grassland Water District canal first while the canal is dry and the pipeline will be constructed following that period or concurrently.

2.1.6 Developed Condition

Post-construction surface drainage will percolate in the same manner as the pre-existing conditions.

2.2 PERMITS AND GOVERNING DOCUMENTS

The following documents have been taken into account while preparing this UPPP:

- Regional Water Board requirements, Basin Plan requirements
- Contract Documents
- Air Quality regulations and permits

2.3 STORMWATER RUN-ON FROM OFFSITE AREAS

There is no anticipated offsite run-on to this construction site due to site topography.

2.4 CONSTRUCTION SCHEDULE

The proposed construction schedule is between June 1, 2025 and May 31, 2026.

2.5 POTENTIAL CONSTRUCTION ACTIVITY AND POLLUTANT SOURCES

Appendix C includes a list of construction activities and associated materials that are anticipated to be used onsite as well as the pollutant source assessment form that was completed for the project. These activities and associated materials will or could potentially contribute pollutants, other than sediment, to stormwater runoff.

The anticipated activities and associated pollutants were used in Section 3 to select the BMPs for the project. Locations of anticipated pollutants and associated BMPs are shown on the Site Map in Appendix A.

Additionally, proper measures will be taken to ensure that trench spoils or any other soils disturbed during construction activities that are contaminated are not discharged with stormwater or non-stormwater discharges into storm drains or water bodies (except pursuant to a separate NPDES Permit). If contaminated soils are found on site, and the responsible party cannot be identified or fails to take action, soils will be sampled to determine proper handling and protect public safety. The appropriate local, State, and federal agencies along with the appropriate Regional Water Board will be notified when contaminated soils are observed.

For sampling requirements for non-visible pollutants associated with construction activity, please refer to Section 5.5. For a full and complete list of onsite pollutants, refer to the Safety Data Sheets (SDS), which are retained onsite at the construction trailer or are available electronically at the site.

2.6 IDENTIFICATION OF NON-STORMWATER DISCHARGES

Non-stormwater discharges into storm drainage systems or waterways, are not authorized and listed in the UPPP, or authorized under a separate NPDES permit, are prohibited. Non-stormwater discharges that are authorized from this project site include the following:

- Irrigation of Vegetative Erosion Control Measures
- Fire Hydrant Flushing, Pipe Testing and Flushing
- Uncontaminated Groundwater Dewatering

These authorized non-stormwater discharges will be managed with the stormwater and non-stormwater BMPs described in Section 3 of this SWPPP and will be minimized under the direction of the Contractor and the LRP's representatives. Additionally, the non-stormwater discharges not applicable to this project are still allowable granted they do not contact potential pollutant sources. Activities at this site that may result in unauthorized non-stormwater discharges include:

- Vehicle/Equipment Cleaning, Fueling, and Maintenance Operations
- Vehicle/Equipment Wash water including Concrete Washout Water
- Wash water from Cleaning Painting Equipment
- Concrete cutting/coring operation slurries, PCC grinding or AC grinding operations
- Slurries from Concrete or Mortar Mixing operations
- Slurries from Drilling or Boring operations
- Blast residue from High-Pressure Washing
- Dust Control runoff or dust control palliatives
- Liquid waste, Sanitary/Septic wastes, etc.

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- Chemical leaks and/or spills of any kind including but not limited to petroleum, paints, curing compounds, etc.

Steps will be taken, including the implementation of appropriate BMPs, to ensure that unauthorized discharges are eliminated, controlled, disposed, or treated on-site.
Discharges of construction materials and wastes, such as fuel or paint, resulting from dumping, spills, or direct contact with rainwater or stormwater runoff, are also prohibited.

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Section 3 Best Management Practices

3.1 SCHEDULE FOR BMP IMPLEMENTATION

BMPs will be implemented as per the schedules indicated in Tables 3-1 – 3-4. BMPs will be stockpiled onsite at all times to facilitate deployment.

3.2 EROSION AND SEDIMENT CONTROL

Erosion and sediment controls are required for this project to provide effective reduction or elimination of sediment related pollutants in stormwater discharges and authorized non-stormwater discharges from the Site. Applicable BMPs are identified in this section for erosion control, sediment control, tracking control, and wind erosion control.

3.2.1 Erosion Control

Erosion control, also referred to as soil stabilization, consists of source control measures that are designed to prevent soil particles from detaching and becoming transported in stormwater runoff. Erosion control BMPs protect the soil surface by covering and/or binding soil particles.
This construction project will implement the following practices to provide effective temporary and final erosion control during construction:

1. Preserve existing vegetation where required and when feasible.
2. The area of soil disturbing operations shall be controlled such that the Contractor is able to implement erosion control BMPs quickly and effectively.
3. Stabilize non-active areas within 14 days of cessation of construction activities or sooner if stipulated by local requirements.
4. Control erosion in concentrated flow paths by applying erosion control blankets, check dams, erosion control seeding, or alternate methods.
5. Prior to the completion of construction, apply permanent erosion control to remaining disturbed soil areas.

Sufficient erosion control materials shall be maintained onsite to allow implementation in conformance with this SWPPP.
The following erosion control BMP selection table, Table 3-2 indicates the BMPs that will be implemented to control erosion on the construction site. Fact Sheets for temporary erosion control BMPs are provided in Appendix D.

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These temporary erosion control BMPs shall be implemented in conformance with the following guidelines and as outlined in the BMP Factsheets provided in Appendix D. If there is a conflict between documents, the Site Map will prevail over narrative in the body of the SWPPP or guidance in the BMP Fact Sheets. Site specific details in the Site Map prevail over standard details included in the Site Map. The narrative in the body of the SWPPP prevails over guidance in the BMP Fact Sheets.

Scheduling

The Contractor shall sequence construction activities with the installation of both soil stabilization and sediment control measure BMPs to reduce the discharge of sediment and pollutants to storm drain facilities or watercourses. The contractor shall create a schedule detailed enough to show major activities sequences with the implementation of construction site BMPs. Scheduling will be used as much as practicable to reduce areas of in-active soil disturbance per BMP detail EC-1.

Preservation of Existing Vegetation

The Contractor shall not disturb or destroy any vegetation or habitat unless absolutely necessary for the performance of the Work. The Contractor shall inform onsite personnel of the work limits

and not to disturb vegetation outside those limits, including travel to and from the project site. The protection and preservation of such vegetation shall serve to control erosion and filter out sediment.

Geotextiles and Mats

The Contractor will use plastic covers to cover exposed soil and stockpiled material areas. Covers will be placed over stockpiles prior to forecast storm events and anchored to prevent damage by wind. Plastic covers will be used in conjunction with sandbags or fiber rolls to cover all stockpiles within 48 hours of stockpiling material or before a forecasted storm event, whichever occurs first. Plastic sheeting will also be used under equipment to catch drips if the equipment is not in use.

Earth Dike and Drainage Swales

Dikes and swales may be implemented as part of the engineered project design. If the Contractor proposes the use of dikes or swales as a temporary measure, the dike and/or swale shall be designed and stamped by a licensed CA Civil Engineer.

Soil Preparation-Roughening

In areas of high traffic (travel banks, dirt roads) and bank slopes equipment will be utilized to compact and track walk surfaces that require stabilization but not a seed mixture or other impervious treatment. The slope compaction will aid in final stabilization and prevent sediment erosion runoff into surrounding agricultural fields. The roughing and compaction will also reduce the potential of over-seeding the slope, introducing seed product to the adjacent agricultural fields or require watering during drought conditions.

Non-Vegetated Stabilization

Non-Vegetative Stabilization is to be used in conjunction with Soil Preparation Roughening. In addition to Soil Preparation Roughening, the Contractor shall use impervious concrete surfaces and rock slope stabilization (rip rap per construction plans) to prevent sediment erosion and potential pollutant run-off after construction is complete. No non-native chemical binders will be used other than concrete without Owner approval.

Wind Erosion Control

The water will be applied using water trucks. Wind Erosion Control and Water Conservation Practices BMPs will be implemented to provide dust control and prevent discharges from dust control activities and water supply equipment. Water application rates will be minimized as necessary to prevent runoff and ponding and water equipment leaks will be repaired immediately.

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Table 3-1 Erosion Control BMPs

Fact Sheet[1]	BMP Name	Considered for the Project [2]	Construction Phase Used				
			Demo/ Pre-Construction	Grading	Utilities	Paving/ Concrete	Final Stabilization
EC-1	Scheduling	✓	X	X	X	X	X
EC-2	Preservation of Existing Vegetation	✓	X	X	X	X	X
EC-3	Hydraulic Mulch	✓	n/a				
EC-4	Hydroseed	✓	n/a				
EC-5	Soil Binders	✓	n/a				
EC-6	Straw Mulch	✓	n/a				
EC-7	Geotextiles and Mats	✓	X	X	X	X	X
EC-8	Wood Mulching	✓	n/a				
EC-9	Earth Dike and Drainage Swales	✓	X	X	X	X	X
EC-10	Velocity Dissipation Devices	✓	n/a				
EC-11	Slope Drains	✓	n/a				
EC-12	Stream Bank Stabilization		n/a				
EC-14	Compost Blankets	✓	n/a				
EC-15	Soil Preparation-Roughening		X	X	X	X	X
EC-16	Non-Vegetated Stabilization	✓	X	X	X	X	X
WE-1	Wind Erosion Control	✓	X	X	X	X	X

Notes:
1. CASQA Fact Sheets, 2023 Edition or most current.
2. All run-on and runoff from the construction site shall be managed.

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3.2.2 Sediment Controls

Sediment controls are temporary or permanent structural measures that are intended to complement the selected erosion control measures and reduce sediment discharges from active construction areas. Sediment controls are designed to intercept and settle out soil particles that have been detached and transported by the force of water.

The following sediment control BMP selection table indicates the BMPs that will be implemented to control sediment on the construction site. Fact Sheets for temporary sediment control BMPs are provided in Appendix D.

These temporary sediment control BMPs will be implemented in conformance with the following guidelines and in accordance with the BMP Fact Sheets provided in Appendix D. If there is a conflict between documents, the Site Map will prevail over narrative in the body of the SWPPP or guidance in the BMP Fact Sheets. Site specific details in the Site Map prevail over standard details included in the Site Map. The narrative in the body of the SWPPP prevails over guidance in the BMP Fact Sheets.

Silt Fence

The Contractor shall use silt fence as specified in the Site Maps and by the QSP. Silt fences shall be installed per the BMP guidance sheet and shall not contribute to erosion/pollutant discharges. Repair silt fences within 24 hours of discovering damage. Remove and properly disposed of accumulated sediment with 24 hrs.

Check Dams

The Contractor shall use check dams in locations where fiber rolls are not proven effective to control run-off in concentrated drainage paths. The check dams shall be constructed of gravel or sandbag, packed to prevent leakage through the structure and shall be installed per the BMP guidance sheet and shall not contribute to erosion/pollutant discharges. Repair check dams and remove accumulated sediment within 24 hours of discovering damage/build-up.

Fiber Rolls

The Contractor shall install fiber rolls downstream of the drainage perimeter as needed where shown on the Site Maps. Obstruction including rocks, clods, and debris greater than one inch in diameter will be removed from the ground before placing fiber rolls. Repair fiber rolls within 24 hrs. of discovering damage.

Gravel Bag Berm, Sandbag Barrier

Bags will be used as a linear sediment barrier for stockpiled materials; bags must be placed in a single layer and placed end to end to eliminate gaps. Bags will be placed along the down gradient side of any parked vehicles and equipment thereby diverting and filtering the rain runoff water around the vehicle and equipment in the event of imminent rain. Temporary bags shall be maintained to provide for adequate sediment holding capacity. Sediment deposits shall be removed when the deposit reaches one third of the temporary bag barrier height. Removed sediment shall be deposited within the project in such a way that the sediment is not subject to erosion by wind or water, or as directed by the QSD/P, Owner and/or Engineer.

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Street Sweeping

The Contractor shall use hand or mechanical methods such as vacuuming to perform street sweeping where noticeable tracking of material from the job site onto adjacent streets occurs. Street sweeping shall start at the beginning of construction activities and continue daily and on as needed basis until the completion of the project, or as directed by the Owner or QSD/P. Road sweeping and vacuuming will occur during soil hauling and as necessary to keep streets clear of tracked material and debris. Washing of sediment tracked onto streets into storm drains will not occur.

Storm Drain Inlet/Culvert Inlet Protection

Inlet protection will be used at all inlets within the project limits. Temporary devices constructed around storm drain inlets improve the quality of water being discharged to inlets or catch basins by ponding sediment-laden runoff and increasing settling time. Inlet protection shall be placed in a manner that does not cause ponding or pose a threat to pedestrian or traffic safety. Approximate locations of inlets are shown on the Site Maps and the Contractor shall inspect exact locations and protect them prior to commencing work. After construction, the contractor shall remove this BMP from all locations where implemented. This is appropriate for small drainage areas only. This BMP will be used where sediment-laden surface runoff may enter an inlet, where drainage areas have not been permanently stabilized and prior to a rain event.

Stabilized Construction Entrance and Exit

A stabilized construction entrance/exit will be constructed and maintained at construction site entrances and exits. The site entrance/exit will be stabilized to reduce tracking of sediment as a result of construction traffic. The entrance shall be designated and graded to prevent runoff from leaving the site. Stabilization material will be 3-inch minus aggregate over filter fabric. The entrance shall be flared where meets the existing road to provide an adequate turning radius. A site entrance/exit shall only be installed to reduce tracking of sediment during dirt-hauling activities that extend over a one-week time period.

Stabilized Construction Roadway

A stabilized construction roadway will be constructed and maintained at construction site for use during construction and as a post-construction stabilization measure. The site road will be stabilized to reduce tracking of sediment as a result of construction traffic. The road shall be designated and graded inward to prevent runoff from leaving the site. Material will be 3-inch minus aggregate over filter fabric. The roadway will be constructed to function in tandem with a stabilized entrance/exit.

Table 3-2 Temporary Sediment Control BMPs

Fact Sheet[1]	BMP Name	Considered for the Project[2]	Construction Phase Used				
			Demo/ Pre-Construction	Grading	Utilities	Paving/ Concrete	Final Stabilization
SE-1	Silt Fence	✓	X	X	X	X	X
SE-2	Sediment Basin		n/a				
SE-3	Sediment Trap		n/a				
SE-4	Check Dams		X	X	X	X	X
SE-5	Fiber Rolls	✓	X	X	X	X	X
SE-6	Gravel Bag Berm	✓	X	X	X	X	X
SE-7	Street Sweeping	✓	X	X	X	X	X
SE-8	Sandbag Barrier		X	X	X	X	X
SE-9	Straw Bale Barrier		n/a				
SE-10	Storm Drain Inlet Protection	✓	X	X	X	X	X
SE-11	ATS		n/a				
SE-12	Manufactured Linear Sediment Controls		n/a				
SE-13	Compost Sock and Berm	✓	n/a				
SE-14	Biofilter Bags	✓	n/a				
TC-1	Stabilized Construction Entrance and Exit	✓	X	X	X	X	X
TC-2	Stabilized Construction Roadway		n/a				
TC-3	Entrance Outlet Tire Wash		n/a				

Notes:
1. CASQA Fact Sheets, 2023 Edition or most current.
2. All run-on and runoff from the construction site shall be managed.

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3.3 NON-STORMWATER CONTROLS AND WASTE AND MATERIALS MANAGEMENT

3.3.1 Non-Stormwater Controls

Non-stormwater discharges into storm drainage systems or waterways which are not authorized are prohibited. Non-stormwater discharges for which a separate NPDES permit is required by the local Regional Water Board are prohibited unless coverage under the separate NPDES permit has been obtained for the discharge. The selection of non-stormwater BMPs is based on the list of construction activities with a potential for non-stormwater discharges identified in Section 2.6 of this SWPPP.

The following non-stormwater control BMP selection table indicates the BMPs that will be implemented to control sediment on the construction site. Fact Sheets for temporary non-stormwater control BMPs are provided in Appendix D.

Non-stormwater BMPs will be implemented in conformance with the following guidelines and in accordance with the BMP Fact Sheets provided in Appendix D. If there is a conflict between documents, the Site Map will prevail over narrative in the body of the SWPPP or guidance in the BMP Fact Sheets. Site specific details in the Site Map prevail over standard details included in the Site Map. The narrative in the body of the SWPPP prevails over guidance in the BMP Fact Sheets.

Water Conservation Practices

The Contractor shall implement water conservation practices when water is used on the project site. The Contractor shall make sure that any water leakage is repaired promptly, and all water equipment will be kept in good working condition. Vehicles and equipment will not be washed on site. Water will not be used to clean construction areas and authorization must be obtained before washing anything at the job site with water that could possibly discharge into a storm drain system or watercourse. Discharges must be reported immediately. Water should be directed from the job site to areas where it can infiltrate into the ground. Direct water from off-site sources around the job site if practicable.

Dewatering Operation

Water shall not be released/discharged from the Project site without testing and specific authorization from the governing agency, receiving land/property owner, and Project Owner/LRP.

Paving and Grinding Operation

The Contractor shall perform some paving, grinding, sealing, and sawcutting operations throughout the project site. Do not allow water or slurry during sawcutting or grinding of existing PCC or AC to enter storm drains or water courses, cover drain inlets prior to these operations. Whenever precipitation is forecasted, limit paving, sawcutting, and grinding to places where runoff can be captured. Residue from sawcutting or grinding operations shall be picked up by means of a vacuum. Noticeable tracking and fines shall be removed to prevent sediment and grindings from entering drainage systems and watercourses. Drip protection will be placed under paving equipment when not in use. Paving equipment will be staged on level ground and drip protection will be free of rips and holes and will be bermed.

Illicit Connection/Discharge

The site will be inspected before the project commences and regularly during the project for illicit connections or illegal dumping or discharge. If any are found, they will be reported to the QSD/P

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and/or Owner at the time of discovery. Store chemicals in watertight containers (with appropriate secondary containment to prevent any spillage or leakage) or in a storage shed (completely enclosed).

Potable Water/Irrigation (includes non-potable water)

Potable water will be used for dust control purposes. Irrigated areas within the construction limits will be inspected for excess watering. Watering times and schedules will be adjusted to ensure that the appropriate amount of water is being used and to minimize runoff.

Vehicle and Equipment Cleaning

Vehicle and equipment cleaning or washing at the job site will not be allowed except what is necessary to control vehicle tracking or hazardous waste using NS-8. Clean or wash vehicles and equipment in a structure equipped with disposal facilities. Vehicles may be washed in an outside area if the area is, paved with asphalt concrete, HMA, or PCC, surrounded by a containment berm, and equipped with a sump to collect and dispose of wash water.

Vehicle and Equipment Fueling

Construction vehicles will be fueled offsite when possible. When necessary, NS-9 will be used on all vehicles that cannot be fueled offsite. If fueling or maintenance must be done onsite, activities must be performed on level ground in areas protected from stormwater run-on and runoff.

Vehicle and Equipment Maintenance

Most construction vehicles will be stored offsite, but NS-10 will be utilized for all equipment that must be stored onsite. Plastic Sheeting will be placed under equipment that is not in use.

Concrete Curing

The Contractor shall not overspray chemical curing compound. Minimize the drift by spraying as close to the concrete as possible. Cover drainage inlets before applying the curing compound. Minimize the use and discharge of water by using wet blankets or similar methods to maintain moisture while curing concrete.

Concrete Finishing

Collect and dispose of water and solid waste from high-pressure water blasting. Cover drainage inlets within 50 feet before sandblasting. Minimize drift of dust and blast material by keeping the nozzle close to the surface of the concrete. The blast residue may contain hazardous material. Inspect concrete finishing containment structures for damage before each day of use and before predicted precipitation. Remove liquid and solid waste from containment structures after each work shift.

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Table 3-3 Temporary Non-Stormwater BMPs

Fact Sheet[1]	BMP Name	Considered for the Project[2]	Construction Phase Used				
			Demo/ Pre-Construction	Grading	Utilities	Paving/ Concrete	Final Stabilization
NS-1	Water Conservation Practices	✓	X	X	X	X	X
NS-2	Dewatering Operation	✓	X	X	X	X	X
NS-3	Paving and Grinding Operation		X	X	X	X	X
NS-4	Temporary Stream Crossing		n/a				
NS-5	Clear Water Diversion		n/a				
NS-6	Illicit Connection/ Discharge	✓	X	X	X	X	X
NS-7	Potable Water/Irrigation	✓	X	X	X	X	X
NS-8	Vehicle and Equipment Cleaning	✓	X	X	X	X	X
NS-9	Vehicle and Equipment Fueling	✓	X	X	X	X	X
NS-10	Vehicle and Equipment Maintenance	✓	X	X	X	X	X
NS-11	Pile Driving Operation		n/a				
NS-12	Concrete Curing		X	X	X	X	X
NS-13	Concrete Finishing		X	X	X	X	X
NS-14	Material and Equipment Use Over Water		n/a				
NS-15	Demolition Removal Adjacent to Water		n/a				
NS-16	Temporary Batch Plants		n/a				

Notes:
1. CASQA Fact Sheets, 2023 Edition or most current.
2. All run-on and runoff from the construction site shall be managed.

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3.3.2 Materials Management and Waste Management

Materials management control practices consist of implementing procedural and structural BMPs for handling, storing, and using construction materials to prevent the release of those materials into stormwater discharges. The amount and type of construction materials to be utilized at the Site will depend upon the type of construction and the length of the construction period. The materials may be used continuously, such as fuel for vehicles and equipment, or the materials may be used for a discrete period, such as soil binders for temporary stabilization.

Waste management consist of implementing procedural and structural BMPs for handling, storing, and ensuring proper disposal of wastes to prevent the release of those wastes into stormwater discharges.

Materials and waste management pollution control BMPs will be implemented to minimize stormwater contact with construction materials, wastes, and service areas; and to prevent materials and wastes from being discharged off-site. The primary mechanisms for stormwater contact that shall be addressed include:

- Direct contact with precipitation
- Contact with stormwater run-on and runoff
- Wind dispersion of loose materials
- Direct discharge to the storm drain system through spills or dumping
- Extended contact with some materials and wastes, such as asphalt cold mix and treated wood products, which can leach pollutants into stormwater.

A list of construction activities is provided in Section 2. The following Materials and Waste Management BMP selection table, Table 3-4, indicates the BMPs that shall be implemented to handle materials and control construction site wastes associated with these construction activities. Fact Sheets for Materials and Waste Management BMPs are provided in Appendix D.

Material management BMPs will be implemented in conformance with the following guidelines and in accordance with the BMP Fact Sheets provided in Appendix D. If there is a conflict between documents, the Site Map will prevail over narrative in the body of the SWPPP or guidance in the BMP Fact Sheets. Site specific details in the Site Map prevail over standard details included in the Site Map. The narrative in the body of the SWPPP prevails over guidance in the BMP Fact Sheets.

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Material Delivery and Storage

The Contractor shall establish an onsite construction yard for this project and shall utilize the yard for storage of materials. Secondary containment shall be provided for any hazardous chemicals as required by the General Permit and other Federal and State regulations. Construction materials shall be brought onsite when needed to complete construction operations. Employees and subcontractors shall be trained on proper material delivery and storage practices. The contractor shall implement material delivery and storage primarily during unloading and handling of materials onsite.

Material Use

The Contractor shall use materials in accordance with the Manufacturer's specifications to avoid misuse. The Contractor shall mix and prepare a proper amount of material to avoid excess at the end of each work shift. Drip pans, safety data sheets, a material inventory, emergency contact numbers, spill kits, and absorbent pads shall be kept onsite and employed for any spills that occur.

Stockpile Management

Implement water pollution control practices within 48 hours of stockpiling material or before a forecasted storm event, whichever occurs first. If stockpiles are being used, do not allow soil, sediment, or other debris to enter storm drains, open drainages, and watercourses. Active and inactive soil stockpiles and stockpiles must be, covered with plastic tarpaulins and surrounded with a linear sediment barrier, such as gravel bags.

Spill Prevention and Control

Throughout the project limits the contractor will implement spill and leak prevention procedures for chemicals and hazardous substances when encountered on the jobsite. The project foreman will keep a spill and clean up kit in his truck at all times while onsite to allow for quick clean-up of all spills or leaks. Material and waste storage areas clean will be kept clean, well-organized,

and equipped with enough cleanup supplies for the material being stored. As soon as it is safe, contain and clean up spills of petroleum materials and sanitary and septic waste substances listed under 40 CFR, Parts 110, 117, and 302.

Solid Waste Management

Throughout project, the Contractor will load solid wastes directly into trucks and/or waste disposal containers for off-site disposal weekly. Waste disposal containers will be covered at the end of every business day and during rain events. There will be watertight, closed-lid dumpsters to contain the solid waste generated by work activities. Dumpsters and trash receptacles will be placed in locations where workers eat lunch. When refuse reaches the fill line, the dumpsters shall be emptied. Dumpster will not be allowed to be washed out at the job site.

Hazardous Waste Management

Throughout the project limits, should the Contractor encounter hazardous waste during the course of the project, WM-6 practices will be implemented.

Contaminated Soil Management

Throughout the project limits, should the contractor encounter contaminated soil(s) during the course of the project, WM-7 practices will be implemented.

Concrete Waste Management

The Contractor will implement concrete waste management in the construction project yard and multiple areas throughout the construction project area. The temporary concrete washout will be furnished, maintained, and removed as necessary. The contractor will use portable temporary concrete washouts as a water pollution control practice for any concrete waste that is produced. All concrete washouts will be properly marked, covered before any rain event, and will be maintained properly. Employees, subcontractors, and suppliers shall be fully educated on the concrete waste management techniques outlined in the following practices and procedures: PCC and AC wastes shall not be allowed to enter storm drains or watercourses. Concrete pours or operations that will generate concrete slurries will not be conducted during or immediately prior to rainfall events.

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Sanitary-Septic Waste Management

Contractor shall not bury or discharge wastewater from a sanitary or septic system within the highway. Place a portable sanitary facility at least 50 feet away from storm drains, receiving waters, and flow lines. Portable toilets shall be inspected daily and maintained weekly.

Liquid Waste Management

The Contractor shall implement the Liquid Waste Management BMP when liquid wastes are anticipated to prevent it from entering the storm drain and receiving waters. Hold liquid waste in structurally sound, leak-proof containers, such as roll-off bins or portable tanks. Liquid waste containers must be of sufficient quantity and volume to prevent overflow, spills, and leaks. Store containers at least 50 feet from moving vehicles and equipment. All liquid wastes shall be stored in covered storage areas and within leak proof containers. Liquid wastes shall be properly collected and disposed of offsite.

Table 3-4 Temporary Materials Management BMPs

Fact Sheet[1]	BMP Name	Considered for Project[2]	Construction Phase Used				
			Demo/ Pre-Construction	Grading	Utilities	Paving/ Concrete	Final Stabilization
WM-01	Material Delivery and Storage	✓	X	X	X	X	X
WM-02	Material Use	✓	X	X	X	X	X
WM-03	Stockpile Management	✓	X	X	X	X	X
WM-04	Spill Prevention and Control	✓	X	X	X	X	X
WM-05	Solid Waste Management	✓	X	X	X	X	X
WM-06	Hazardous Waste Management	✓	X	X	X	X	X
WM-07	Contaminated Soil Management		X	X	X	X	X
WM-08	Concrete Waste Management	✓	X	X	X	X	X
WM-09	Sanitary-Septic Waste Management	✓	X	X	X	X	X
WM-10	Liquid Waste Management		X	X	X	X	X

Notes:
1. CASQA Fact Sheets, 2023 Edition or most current.
2. All run-on and runoff from the construction site shall be managed.

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Section 4 BMP Observation and Maintenance

4.1 BMP OBSERVATION AND MAINTENANCE

Routine observations of BMPs, along with observations before and after precipitation events are strongly recommended. Maintenance, repair, or design and implementation of new BMPs alternatives will begin withing 72 hours of the identification of failures or other shortcomings. Corrections will be completed as soon as possible, prior to the next forecasted precipitation event. The Contractor will verify that all BMP maintenance and repairs are appropriately implemented. Specific details for maintenance, inspection, and repair of Construction Site BMPs can be found in the BMP Factsheets in Appendix D.

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Section 5 Construction Site Monitoring Program

5.1 Purpose

This Construction Site Monitoring Program was developed to address the following objectives:

1. To determine whether non-visible pollutants discharged from the construction site and are causing or contributing to exceedances of water quality objectives;
2. To determine whether immediate corrective actions, additional BMP implementation, or UPPP revisions are necessary to reduce pollutants in stormwater discharges and authorized non-stormwater discharges;
3. To determine whether BMPs included in the UPPP are effective in preventing or reducing pollutants in stormwater discharges and authorized non-stormwater discharges.

5.2 Monitoring Locations

Monitoring locations are shown on the Site Maps in Appendix A. Monitoring locations are described in Section 5.

Whenever changes in the construction site might affect the appropriateness of sampling locations, the sampling locations shall be revised accordingly. All such revisions shall be implemented as soon as feasible and the SWPPP amended. Temporary changes that result in a one-time additional sampling location do not require a SWPPP amendment.

5.3 Safety and Monitoring Exemptions

Safety practices for sample collection will be in accordance with the State of California, Department of Transportation "Construction Site Monitoring Program Guidance Manual" (Aug 2013). A summary of the safety requirements that apply to sampling personnel is provided below.

- Appropriate Construction Site Clothing – Pants, Boots
- PPE – Hard Hat, High Visibility Reflective Vest, Safety Glasses

This project is not required to collect samples or conduct visual observations under the following conditions:

- During dangerous weather conditions such as electrical storms, flooding, and high winds above 40 miles per hour;
- Outside of scheduled site operating hours; or
- When the site is not accessible to personnel.

Scheduled site business hours are Monday – Friday, 8:00 am – 5:00 pm excluding standard holidays and scheduled non-operational times.

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5.4 Visual Monitoring

5.4.1 Routine Observations

Routine site observations and visual monitoring are necessary to confirm that the project is in compliance.

5.4.1.1 Routine BMP Inspections

Inspections of BMPs are conducted to identify and record:

- BMPs that are properly installed;
- BMPs that need maintenance to operate effectively;
- BMPs that have failed; or
- BMPs that could fail to operate as intended.

5.4.1.2 Non-Stormwater Discharge Observations

Each drainage area will be inspected for the presence of or indications of prior unauthorized and authorized non-stormwater discharges. Inspections will record:

- Presence or evidence of any non-stormwater discharge (authorized or unauthorized);
- Identification and elimination of unauthorized non-stormwater discharges
- Pollutant characteristics (floating and suspended material, sheen, discoloration, turbidity, odor, etc.); and
- Source of discharge.

5.4.2 Visual Monitoring Follow-Up

Maintenance, repairs, and correction of deficiencies, including design changes to BMPs, identified by the observations or inspections, including required repairs or maintenance of BMPs, shall be initiated within 72 hours of identification and completed as soon as possible, prior to the next forecasted precipitation event. When design changes to BMPs are required, the UPPP shall be amended to reflect the changes.

5.5 Water Quality Sampling and Analysis

5.5.1 Sampling and Analysis Plan for Non-Visible Pollutants in Stormwater Runoff Discharges

This Sampling and Analysis Plan for Non-Visible Pollutants describes the sampling and analysis strategy and schedule for monitoring non-visible pollutants in stormwater runoff discharges from the project site.

Sampling for non-visible pollutants, including those associated with TMDLs will be conducted when (1) a breach, leakage, malfunction, or spill is observed; and (2) the leak or spill has not been cleaned up prior to the rain event; and (3) there is the potential for discharge of non-visible pollutants to surface waters or drainage system.

Table 5-1 summarizes the potential non-visible pollutants identified in the pollutant source assessment in Section 2, and the water quality constituent or indicator for that pollutant. All drainage areas have the potential for non-visible pollutants. Drainage areas where the source is present are shown on the Site Maps in Appendix A.

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5.5.1.1 Sampling Schedule

Samples for the potential non-visible pollutant(s) and a sufficiently large unaffected background sample shall be collected during the first eight hours of discharge from rain events that result in a sufficient discharge for sample collection. Samples shall be collected during the site's scheduled hours and shall be collected regardless of the time of year and phase of the construction.

Collection of discharge samples for non-visible pollutant monitoring will be triggered only when any of the following conditions are observed during site inspections conducted prior to or during a rain event.

- Materials or wastes containing potential non-visible pollutants are not stored under watertight conditions. Watertight conditions are defined as (1) storage in a watertight container, (2) storage under a watertight roof or within a building, or (3) protected by temporary cover and containment that prevents stormwater contact and runoff from the storage area.
- Materials or wastes containing potential non-visible pollutants are stored under watertight conditions, but (1) a breach, malfunction, leakage, or spill is observed, (2) the leak or spill is not cleaned up prior to the rain event, and (3) there is the potential for discharge of non-visible pollutants to surface waters or a storm drain system.
- A construction activity, including but not limited to those in Section 2, with the potential to contribute non-visible pollutants (1) was occurring during or within 24 hours prior to the rain event, (2) BMPs were observed to be breached, malfunctioning, or improperly implemented, and

(3) there is the potential for discharge of non-visible pollutants to surface waters or a storm drain system.

- Soil amendments that have the potential to change the chemical properties, engineering properties, or erosion resistance of the soil have been applied, and there is the potential for discharge of non-visible pollutants to surface waters or a storm drain system.
- Stormwater runoff from an area contaminated by historical usage of the site has been observed to combine with stormwater runoff from the site, and there is the potential for discharge of non-visible pollutants to surface waters or a storm drain system.

5.5.1.2 Sampling Locations

Sampling locations are based on proximity to planned non-visible pollutant storage, occurrence or use, accessibility for sampling, and personnel safety. Common sampling locations include but are not limited to the contractor storage and staging yard and areas of concrete use.

5.5.1.3 Monitoring Preparation

Non-visible pollutant samples will be collected by:
Contractor ☒ Yes ☐ No

An adequate stock of monitoring supplies and equipment for monitoring non-visible pollutants will be available on the project site prior to a sampling event. Monitoring supplies and equipment will be stored in a cool temperature environment that will not come into contact with rain or direct sunlight. The QSP or QSP Delegates responsible for sampling will be available to collect samples in accordance with the sampling schedule. Supplies maintained at the project site will include, but are not limited to, clean powder-free nitrile gloves, sample collection equipment, coolers, appropriate number and volume of sample bottles, identification labels, re-sealable storage bags, paper towels, personal rain gear, ice, and *Effluent Sampling Field Log Sheets* and Chain of Custody (CoC) forms, which are provided in Appendix F.

5.5.1.4 Analytical Constituents

Table 5-1 lists the specific sources and types of potential non-visible pollutants based on the project pollutant source assessment and the water quality indicator constituent(s) for that pollutant. Table 5-2 provides the specific analytical methods and reporting limits for the potential non-visible pollutants. Analytical methods were selected in compliance with U.S. EPA sufficiently sensitive method requirements in 40 Code of Federal Regulations Part 136, as evidenced by the method detection limit and minimum level.

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Table 5-1 Potential Non-Visible Pollutants and Water Quality Indicator Constituents

Pollutant Source	Pollutant	Water Quality Indicator Constituent
Adhesives		COD, Phenols, SVOCs
Asphalt Paving		VOCs
Cleaning	Acids	pH
	Bleaches	Residual Chlorine
	Solvents	VOCs, SVOCs
	Detergents	MBAS
	TSP	Phosphate
Concrete	Sealants	SVOC, VOCs, pH, Al, Ca, Va, Zn
	Curing Compounds	VOCs, SVOCs, pH
	Ash, Sand, Slag	pH, Al, Ca, Va, Zn
Framing/Carpentry	Treated Wood	Cu, Cr, As, Zn
	Untreated Wood	BOD
	Particle Board	Formaldehyde
Grading/Earthwork	Gypsum/Lime Amendment	pH
	Soils	Turbidity
	Contaminated Soil	BOD, known soil contaminants constituents
Liquid Waste		Constituents specific to materials onsite
Painting	Resins	COD, SVOC
	Thinner	COD, VOCs
	Paint Strippers	VOCs, SVOCs, metals
	Lacquers, varnishes, enamels	COD, VOCs, SVOCs,
	Sealants	COD
	Adhesives	Phenols, SVOCs
Plumbing	Solder, Flux, Pipe fittings	Cu, Pb, Sn, Zn
Removal of Structures/Demolition		Zn, VOCs, PCBs
Sanitary Waste	Portable Toilets, Sewer Line Breaks	BOD, Total/Fecal Coliform
Utility Line Testing		Residual chlorine, Chloramines
Vehicle/Equipment Use	Fuels, Oils, Greases	PCBs, Fuel
	Batteries	Sulfuric Acid, Pb, pH

Note:
Adapted from Attachment S, Caltrans SWPPP/WPCP Preparation Manual vs. 2003 and CASQA Construction BMP Handbook

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5.5.1.5 Sample Collection

Samples of discharge shall be collected at the designated non-visible pollutant sampling locations determined by observed breaches, malfunctions, leakages, spills, operational areas, soil amendment application areas, and historical site usage areas that triggered the sampling event.

Grab samples shall be collected and preserved in accordance with the methods identified in Table 5-2, "Sample Collection, Preservation and Analysis for Monitoring Non-Visible Pollutants". Only the personnel trained on sample collection shall collect samples. Sample collection and handling requirements are described in Section 5.6.

5.5.1.6 Sample Analysis

Samples shall be analyzed using the analytical methods identified in Table 5-2 or the most current US EPA Method identified by the analytical laboratory. Samples will be analyzed by:

Laboratory Name:	BSK Associates
Street Address:	627 N Laverne Ave
City, State Zip:	Fresno, CA 93727
Telephone Number:	559-497-2880
ELAP Certification Number:	1108

Samples will be delivered to the laboratory by the Contractor.

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Table 5-1 Sample Collection, Preservation and Analysis for Monitoring Non-Visible Pollutants

Constituent	Analytical Method	Minimum Sample Volume	Sample Containers	Sample Preservation	Reporting Limit	Maximum Holding Time
pH	Litmus paper or test kits	40 ml	PTFE, plastic, glass	None	9>x>6	15 min
Oil & Grease	EPA 1664A	1 L	Glass amber	HCl	5 mg/L	28 d
Total Suspended Solids	SM 2540-D	500 ml	1 L Poly	None	1 mg/L	7 d
Total Cyanide	SM 4500-CN C, D, or E	250 ml	PTFE, plastic,	NaOH*	0.005 mg/L	14 d
Ammonia (as N)	SM 4500-NH3 B+ C or E	50 ml	125 ml Poly	H2SO4	0.02 mg/L	28 d
Dissolved Ag, Al, As, Cu, Hg, Pb, Se	EPA 200.8	500 ml	PTFE, plastic, glass	HNO3	0.005 mg/L	180 d
Dissolved Fe, Mg, Zn	EPA 200.7	500 ml	PTFE, plastic, glass	HNO3	0.005 mg/L	180 d
Dissolved Hg	EPA 245.1	500 ml	PTFE, plastic, glass	HNO3	0.005 mg/L	180 d
Chemical Oxygen Demand	SM 5220C	10 ml	125 Poly	H2SO4	50 mg/L	28 d
Chlorpyrifos & Diazinon	EPA 8141B	1 L	Glass amber	None	0.7; 2.0 µg/L	7 d
Organochlorine Pesticides	EPA 8081	1 L	Glass amber	None	0.05 – 5 µg/L	7 d
Total Organic Carbon	EPA 9060A	1 L	Glass amber	H_2SO_4	0.05 mg/L	14 d
Notes:						
*Cyanide add NaOH to pH>12; metals add HNO3 if pH<2; reporting limit can vary with the laboratory within range limits						

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Table 5-1. Pollutant Testing Guidance Table[1]

Category	Construction Site Material	Visually Observable?	Pollutant Indicators[2]	Suggested Analyses Field[3]	Laboratory
Asphalt Products	Hot Asphalt	Yes – Rainbow Surface or Brown Suspension	Visually Observable – No Testing Required		
	Asphalt Emulsion				
	Liquid Asphalt (tack coat)				
	Cold Mix				
	Crumb Rubber	Yes – Black, solid material	Visually Observable – No Testing Required		
	Asphalt Concrete (Any Type)	Yes – Rainbow Surface or Brown Suspension	Visually Observable – No Testing Required		
Cleaning Products	Acids	No	**pH** Acidity Anions (acetic acid, phosphoric acid, sulfuric acid, nitric acid, hydrogen chloride)	pH Meter	EPA 150.2 (pH)
					SM 2310B (Acidity)
					EPA 300.0 (Anion)
	Bleaches	No	**Residual Chlorine**	Chlorine test kit	SM 4500-CL G (Res. Chlorine)
	Detergents	Yes – Foam	Visually Observable - No Testing Required		
	TSP	No	**Phosphate**	None	EPA 365.3 (Phosphate)
	Solvents	No	**VOC**	None	EPA 601/602 or EPA 624 (VOC)
			SVOC	None	EPA 625 (SVOC)

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Table 5-1. Continued

Category	Construction Site Material	Visually Observable?	Pollutant Indicators[2]	Suggested Analyses Field[3]	Laboratory
Portland Concrete Cement & Masonry Products	Portland Cement (PCC)	Yes – Milky Liquid	Visually Observable – No Testing Required		
	Masonry products	No	**pH**	pH Meter	EPA 150.2 (pH)
			Alkalinity		SM 2320 (Alkalinity)
	Sealant (Methyl Methacrylate)	No	**Methyl Methacrylate**	None	EPA 625 (SVOC)
			Cobalt		EPA 200.8 (Metal)
			Zinc		
	Incinerator Bottom Ash Bottom Ash Steel Slag Foundry Sand Fly Ash Municipal Solid Waste	No	**Aluminum** **Calcium** **Vanadium** **Zinc**	None	EPA 200.8 (Metal) EPA 200.7 (Calcium)
	Mortar	Yes – Milky Liquid	Visually Observable – No Testing Required		
	Concrete Rinse Water	Yes – Milky Liquid	Visually Observable – No Testing Required		
	Non-Pigmented Curing Compounds	No	Acidity	pH Meter	SM 2310B (Acidity)
			Alkalinity		SM 2320 (Alkalinity)
			pH		EPA 150.2 (pH)
			VOC		EPA 601/602 or EPA 624 (VOC)
			SVOC		EPA 625 (SVOC)

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Table 5-1. Continued

Category	Construction Site Material	Visually Observable?	Pollutant Indicators[2]	Suggested Analyses Field[3]	Laboratory
Landscaping and Other Products	Aluminum Sulfate	No	Aluminum	TDS Meter	EPA 200.8 (Metal)
			TDS		SM2540 C (TDS)
			Sulfate		EPA 300.0 (Sulfate)
	Sulfur-Elemental	No	**Sulfate**	None	EPA 300.0 (Sulfate)
	Fertilizers-Inorganic[4]	No	**Nitrate**	None	EPA 300.0 (Nitrate)
			Phosphate	None	EPA 365.3 (Phosphate)
			Organic Nitrogen	None	SM4500-NH3 C (TKN)
			Potassium	None	EPA 200.8 (Metal)
	Fertilizers – Organic	No	TOC	None	SM 5310 C (TOC)
			Nitrate		EPA 300.0 (Nitrate)
			Organic Nitrogen		SM4500-NH3 C (TKN)
			COD		EPA 410.4 (COD)
	Natural Earth (Sand, Gravel, and Topsoil)	Yes – Cloudiness and turbidity	Visually Observable – No Testing Required		
	Herbicide	No	**Herbicide**	None	Check lab for specific herbicide or pesticide
	Pesticide		**Pesticide**		
	Lime		Alkalinity	pH Meter	SM 2320 (Alkalinity)
			pH		EPA 150.2 (pH)

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Table 5-1. Continued

Category	Construction Site Material	Visually Observable?	Pollutant Indicators[2]	Suggested Analyses Field[3]	Laboratory
Painting Products	Paint	Yes	Visually Observable - No Testing Required		
	Paint Strippers	No	**VOC**	None	EPA 601/602 or EPA 624 (VOC)
			SVOC	None	EPA 625 (SVOC)
	Resins	No	**COD**	None	EPA 410.4 (COD)
			SVOC		EPA 625 (SVOC)
	Sealants	No	**COD**	None	EPA 410.4 (COD)
	Solvents	No	**COD**	None	EPA 410.4 (COD)
			VOC		EPA 601/602 or EPA 624 (VOC)
			SVOC		EPA 625 (SVOC)
	Lacquers, Varnish, Enamels, and Turpentine	No	**COD**	None	EPA 410.4 (COD)
			VOC		EPA 601/602 or EPA 624 (VOC)
			SVOC		EPA 625 (SVOC)
	Thinners	No	VOC	None	EPA 601/602 or EPA 624 (VOC)
			COD		EPA 410.4 (COD)
Portable Toilet Waste Products	Portable Toilet Waste	Yes	Visually Observable – No Testing Required		

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Table 5-1. Continued

Category	Construction Site Material	Visually Observable?	Pollutant Indicators[2]	Suggested Analyses Field[3]	Laboratory
Contaminated Soil [5]	Aerially Deposited Lead[3]	No	**Lead**	None	EPA 200.8 (Metal)
	Petroleum	Yes – Rainbow Surface Sheen and Odor	Visually Observable – No Testing Required		
	Mining or Industrial Waste, etc.	No	**Contaminant Specific**	Contaminant Specific– Check with laboratory	Contaminant Specific – Check with laboratory
Line Flushing Products	Chlorinated Water	No	**Total chlorine**	Chlorine test kit	SM 4500-CL G (Res. Chlorine)
Adhesives	Adhesives	No	COD	None	EPA 410.4 (COD)
			Phenols	None	EPA 420.1 (Phenol)
			SVOC	None	EPA 625 (SVOC)
Dust Palliative Products	Salts (Magnesium Chloride, Calcium Chloride, and Natural Brines)	No	Chloride	None	EPA 300.0 (Chloride)
			TDS	TDS Meter	SM 2540 C (TDS)
			Cations (Sodium, Magnesium, Calcium)	None	EPA 200.7 (Cations)
Vehicle	Antifreeze and Other Vehicle Fluids	Yes – Colored Liquid	Visually Observable – No Testing Required		
	Batteries	No	Sulfuric Acid	None	EPA 300.0 (Sulfate)
			Lead	None	EPA 200.8 (Metal)
			pH	pH Meter	EPA 150.2 (pH)
	Fuels, Oils, Lubricants	Yes – Rainbow Surface Sheen and Odor	Visually Observable – No Testing Required		

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Table 5-1. Continued

Category	Construction Site Material	Visually Observable?	Pollutant Indicators[2]	Suggested Analyses Field[3]	Laboratory
Soil Amendment/ Stabilization Products	Polymer/Copolymer[6, 7]	No	**Organic Nitrogen**	None	EPA 351.3 (TKN)
			BOD	None	SM 5210 B (BOD)
			COD	None	EPA 410.4 (COD)
			DOC	None	SM 5310 C (DOC)
			Nitrate	None	EPA 300.0 (Nitrate)
			Sulfate	None	EPA 300.0 (Sulfate)
			Nickel	None	EPA 200.8 (Metal)
	Straw/Mulch	Yes – Solids	Visually Observable – No Testing Required		
	Lignin Sulfonate	No	Alkalinity	None	SM 2320 (Alkalinity)
			TDS	TDS Meter	SM 2540 C(TDS)
	Psyllium	No	COD	None	EPA 410.4 (COD)
			TOC		SM 5310 C (TOC)
	Guar/Plant Gums	No	COD	None	EPA 410.4 (COD)
			TOC		SM 5310 C (TOC)
			Nickel		EPA 200.8 (Metal)
	Gypsum	No	pH	pH Meter	EPA 150.2 (pH)
			Calcium	None	EPA 200.7 (Calcium)
			Sulfate	None	EPA 300.0 (Sulfate)
			Aluminum	None	EPA 200.8 (Metal)
			Barium		
			Manganese		
			Vanadium		

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Table 5-1. Continued

Category	Construction Site Material	Visually Observable?	Pollutant Indicators[2]	Suggested Analyses Field[3]	Laboratory
Treated Wood Products	Ammoniacal-Copper-Zinc-Arsenate Copper-Chromium-Arsenic Ammoniacal-Copper-Arsenate Copper Naphthenate	No	Arsenic Total Chromium **Copper** Zinc	None	EPA 200.8 (Metal)
	Creosote	Yes – Rainbow Surface or Brown Suspension	Visually Observable – No Testing Required		

Adapted from Attachment S of the *Storm Water Pollution Prevention Plan/Water Pollution Control Program Preparation Manual* (Caltrans, 2007)

Notes:
1. If specific pollutant is known, analyze only for that specific pollutant. See Material Data Safety Sheet to verify.
2. For each construction material, test for one of the pollutant indicators. **Bolded** pollutant indicates lowest analysis cost or best indicator. However, the composition of the specific construction material, if known, is the first criterion for selecting which analysis to use.
3. See www.hach.com, www.lamotte.com, www.ysi.com and www.chemetrics.com for some of the test kits.
4. If the type of inorganic fertilizer is unknown, analyze for all pollutant indicators listed.
5. Only if special handling requirements are required in the Standard Special Provisions for aerially deposited lead
6. If used with a dye or fiber matrix, it is considered visually observable and no testing is required.
7. Based upon research conducted by Caltrans, the following copolymers/polymers do not discharge pollutants and water quality sampling and analysis is not required: Super Tak, M-Binder, Fish Stik, Pro40dc, Fisch-Bond, Soil Master WR, and EarthGuard.

Acronyms:
BOD = biochemical oxygen demand
COD = chemical oxygen demand
DOC = dissolved organic carbon
EPA = United States Environmental Protection Agency
HACH = Global company that provides advanced analytical systems and technical support for water quality testing.
SM = Standard Method
SVOC = semi-volatile organic compounds
TDS = total dissolved solids
TKN = total kjeldahl nitrogen
TOC = total organic carbon
TSP = tri-sodium phosphate
VOC = volatile organic compounds

References:
California Storm Water Quality Task Force, 2001 (now known as the California Stormwater Quality Association). *Construction Storm Water Sampling and Analysis Guidance Document*. October.
National Cooperative Highway Research Program, 2001. *Environmental Impact of Construction and Repair Materials on Surface and Ground Waters, Report 448*.
California Department of Transportation (Caltrans), Environmental Program, 1999. *Soil Stabilization for Temporary Slopes*. October 1.
Caltrans, Division of Environmental Analysis, 2002. *Statewide Storm Water Management Plan*. April.
Caltrans, Environmental Program, 2000. *Statewide Storm Water Quality Practice Guidelines*. August.
Caltrans, 2000a. *Soil Stabilization for Temporary Slopes and District 7 Erosion Control Pilot Study*. June.
Caltrans, 2000b. *Stormwater Monitoring Protocols, Guidance Manual*. May.

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5.5.1.7 Data Evaluation and Reporting

Analytical results shall be provided to the LRP's staff upon receipt. The LRP's staff shall complete an evaluation of the water quality sample analytical results based on a comparison of the results to the unaffected sample.

Runoff/downgradient results shall be compared with the associated upgradient/unaffected results and any associated run-on results. Should the runoff/downgradient sample show an increased level of the tested analyte relative to the unaffected background sample, which cannot be explained by run-on results, the BMPs, site conditions, and surrounding influences shall be assessed to determine the probable cause for the increase.

As determined by the site and data evaluation, appropriate BMPs shall be repaired or modified to mitigate discharges of non-visible pollutant concentrations. Any revisions to the BMPs shall be recorded as an amendment to the SWPPP.

The SWRCB prohibits storm water discharges that contain hazardous substances equal to or in excess of reportable quantities established in 40 C.F.R. §§ 117.3 and 302.4. The results of any non-stormwater discharge results that indicate the presence of a hazardous substance in excess of established reportable quantities shall be immediately reported to the Regional Water Board and other agencies as required by 40 C.F.R. §§ 117.3 and 302.4.

5.6 Quality Assurance and Quality Control

An effective Quality Assurance and Quality Control (QA/QC) plan shall be implemented as part of the CSMP to ensure that analytical data can be used with confidence. QA/QC procedures to be initiated include the following:

- Field logs;
- Clean sampling techniques;
- CoCs;
- QA/QC Samples; and
- Data verification.

Each of these procedures is discussed in more detail in the following sections.

5.6.1 Field Logs

The purpose of field logs is to record sampling information and field observations during monitoring that may explain any uncharacteristic analytical results. Sampling information to be included in the field log include the date and time of water quality sample collection, sampling personnel, sample container identification numbers, and types of samples that were collected. Field observations should be noted in the field log for any abnormalities at the sampling location (color, odor, BMPs, etc.). Field measurements for pH and turbidity should also be recorded in the field log. A Sampling Field Log Sheet is included in Appendix F.

5.6.2 Clean Sampling Techniques

Clean sampling techniques involve the use of certified clean containers for sample collection and clean powder-free nitrile gloves during sample collection and handling. As discussed in this Section, adoption of a clean sampling approach will minimize the chance of field contamination and questionable data results.

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5.6.3 Chain of Custody

The sample CoC is an important documentation step that tracks samples from collection through analysis to ensure the validity of the sample. Sample CoC procedures include the following:

- Proper labeling of samples;
- Use of CoC forms for all samples; and
- Prompt sample delivery to the analytical laboratory.

Analytical laboratories usually provide CoC forms to be filled out for sample containers. An example CoC is included in Appendix F.

5.6.4 QA/QC Samples

QA/QC samples provide an indication of the accuracy and precision of the sample collection; sample handling; field measurements; and analytical laboratory methods. The following types of QA/QC will be conducted for this project:

☒ Field Duplicates at a frequency of [10% per sampling event]
(Required for all sampling plans with field measurements or laboratory analysis)
☒ Equipment Blanks at a frequency of [1 per trip]
(Only needed if the equipment used to collect samples could add the pollutants to sample)
☒ Field Blanks at a frequency of [10% per sampling event]
(Only required if sampling method calls for field blanks)
☒ Travel Blanks at a frequency of [1 per trip]
(Required for sampling plans that include VOC laboratory analysis)

5.6.4.1 Field Duplicates

Field duplicates provide verification of laboratory or field analysis and sample collection. Duplicate samples shall be collected, handled, and analyzed using the same protocols as primary samples. The sample location where field duplicates are collected shall be randomly selected from the discharge locations. Duplicate samples shall be collected immediately after the primary sample has been collected. Duplicate samples must be collected in the same manner and as close in time as possible to the original sample. Duplicate samples shall not influence any evaluations or conclusion.

5.6.4.2 Equipment Blanks

Equipment blanks provide verification that equipment has not introduced a pollutant into the sample. Equipment blanks are typically collected when:

- New equipment is used;
- Equipment that has been cleaned after use at a contaminated site;
- Equipment that is not dedicated for surface water sampling is used; or
- Whenever a new lot of filters is used when sampling metals.

5.6.4.3 Field Blanks

Field blanks assess potential sample contamination levels that occur during field sampling activities. De-ionized water field blanks are taken to the field, transferred to the appropriate container, and treated the same as the corresponding sample type during the course of a sampling event.

5.6.4.4 Travel Blanks

Travel blanks assess the potential for cross-contamination of volatile constituents between sample containers during shipment from the field to the laboratory. De-ionized water blanks are taken along for the trip and held unopened in the same cooler with the VOC samples.

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5.6.5 Data Verification

After results are received from the analytical laboratory, the QSP or QSP Delegates shall verify the data to ensure that it is complete, accurate, and the appropriate QA/QC requirements were met. Data must be verified as soon as the data reports are received. Data verification shall include:

- Check the CoC and laboratory reports.
  Make sure all requested analyses were performed and all samples are accounted for in the reports.
- Check laboratory reports to make sure hold times were met and that the reporting levels meet or are lower than the reporting levels agreed to in the contract.
- Check data for outlier values and follow up with the laboratory.
  Occasionally typographical errors, unit reporting errors, or incomplete results are reported and should be easily detected. These errors need to be identified, clarified, and corrected quickly by the laboratory. The QSP or QSP Delegates should especially note data that is an order of magnitude or more different than similar locations or is inconsistent with previous data from the same location.
- Check laboratory QA/QC results.
  EPA establishes QA/QC checks and acceptable criteria for laboratory analyses. These data are typically reported along with the sample results. The QSP or QSP Delegates shall evaluate the reported QA/QC data to check for contamination (method, field, and equipment blanks), precision (laboratory matrix spike duplicates), and accuracy (matrix spikes and laboratory control samples). When QA/QC checks are outside acceptable ranges, the laboratory must flag the data, and usually provides an explanation of the potential impact to the sample results.
- Check the data set for outlier values and, accordingly, confirm results and re-analyze samples where appropriate.
  Sample re-analysis should only be undertaken when it appears that some part of the QA/QC resulted in a value out of the accepted range. Sample results may not be discounted unless the analytical laboratory identifies the required QA/QC criteria were not met and confirms this in writing.

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Field data including inspections and observations must be verified as soon as the field logs are received, typically at the end of the sampling event. Field data verification shall include:

- Check field logs to make sure all required measurements were completed and appropriately documented;
- Check reported values that appear out of the typical range or inconsistent;
  Follow-up immediately to identify potential reporting or equipment problems, if appropriate, recalibrate equipment after sampling;
- Verify equipment calibrations;
- Review observations noted on the field logs; and
- Review notations of any errors and actions taken to correct the equipment or recording errors.

5.7 Records Retention

All records of stormwater monitoring information and copies of reports (including Annual Reports) must be retained for a period of at least three years from date of submittal or longer if required by the Regional Water Board.

Results of visual monitoring, field measurements, and laboratory analyses must be kept in the SWPPP along with CoCs, and other documentation related to the monitoring.

Records are to be kept onsite while construction is ongoing. Records to be retained include:

- The date, place, and time of inspections, sampling, visual observations, and/or measurements, including precipitation;
- The individual(s) who performed the inspections, sampling, visual observation, and/or field measurements;
- The date and approximate time of field measurements and laboratory analyses;
- The individual(s) who performed the laboratory analyses;
- A summary of all analytical results, the method detection limits and reporting limits, and the analytical techniques or methods used;
- Rain gauge readings from site inspections;
- QA/QC records and results;
- Calibration records;
- Visual observation and sample collection exception records;
- The records of any corrective actions and follow-up activities that resulted from analytical results, visual observations, or inspections;

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Section 6 References

Project Plans and Specifications No. 2019-007 dated February 2025, prepared by Provost & Pritchard Consulting Group

SWRCB (State Water Resources Control Board). (2022). Order 2022-0057-DWQ, NPDES General Permit No. CAS000002: Stormwater Discharges Associated with Construction and Land Disturbing Activities. Available online at: https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction/general_permit_reissuance.html.

CASQA 2023. *Stormwater BMP Handbook: Construction.* Available online at: www.casqa.org

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Appendix A: Site Maps and Drawings

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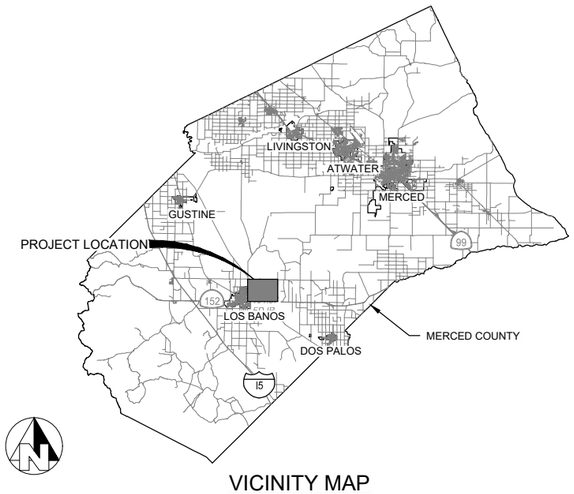
Know what's below. Call before you dig.

WARNING
POWER LINES OVERHEAD

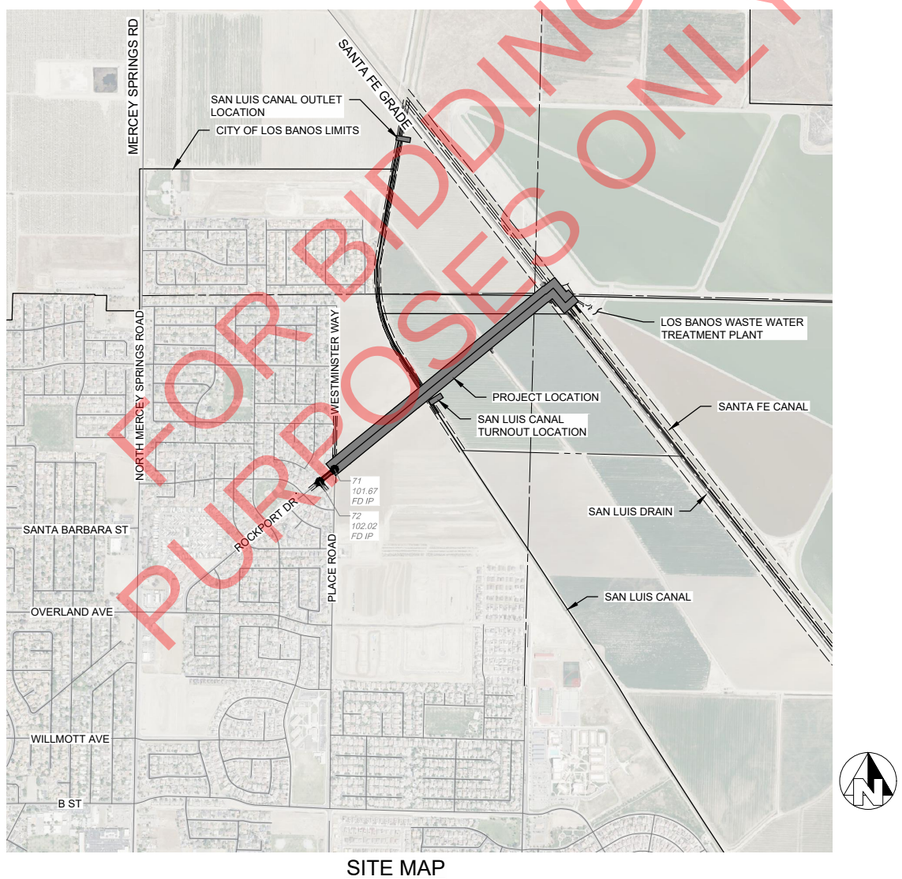
STORMWATER POLLUTION PREVENTION PLANS
BMP SITE MAPS
SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS

LOS BANOS, MERCED COUNTY, CALIFORNIA

SWPPP PREPARED BY:
PROVOST AND PRITCHARD CONSULTING GROUP
455 W FIR AVE
CLOVIS, CA 93611
PH: (559) 449-2700



VICINITY MAP
NOT TO SCALE



SITE MAP
NOT TO SCALE

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GENERAL WATER POLLUTION CONTROL NOTES

1. THE INFORMATION ON THESE DRAWINGS ARE INTENDED TO BE USED AS A GUIDELINE FOR CONTRACTORS AND SUBCONTRACTORS TO INSTALL STORM WATER POLLUTION CONTROL DEVICES AT THE LOCATIONS SHOWN. THESE DRAWINGS ARE TO SHOW THE LOCATIONS FOR EROSION, SEDIMENT, NON-STORM WATER MANAGEMENT AND WASTE MANAGEMENT CONTROL BEST MANAGEMENT PRACTICES (BMPS). THESE DRAWINGS ARE TO BE USED IN CONJUNCTION WITH THE NARRATIVE SECTIONS OF THE STORM WATER POLLUTION PREVENTION PLAN (SWPPP).
2. FIELD CONDITIONS MAY NECESSITATE MODIFICATIONS TO THESE DRAWINGS. THE CONTRACTOR IS RESPONSIBLE TO COORDINATE WITH THE OWNER AND ENGINEER ON ANY UPDATE TO THESE DRAWINGS BASED ON THE CONDITIONS THAT DIFFER FROM THIS DRAWING SET.
3. THE CONTRACTOR SHALL REFER TO THE CALIFORNIA STORM WATER QUALITY ASSOCIATION STORM WATER QUALITY CONSTRUCTION HANDBOOK, OCTOBER 2024 EDITION (OR MOST CURRENT VERSION) FOR SITE BEST MANAGEMENT PRACTICES (BMPs). COPIES OF THE BMPs ARE PROVIDED IN THE SWPPP APPENDIX. ALL BEST MANAGEMENT PRACTICES (BMPS) SHALL BE IN ACCORDANCE WITH THE CONTRACT SPECIFICATIONS.
4. THE CONTRACTOR SHALL SELECT ADDITIONAL ON-SITE SAMPLING LOCATIONS FOR NON-VISIBLE POLLUTANTS AT LOCATIONS NEAR VEHICLE AND EQUIPMENT MAINTENANCE AREAS AND MATERIAL STORAGE AREAS. SAMPLING WILL BE REQUIRED AS SPECIFIED IN THE SECTION 5 OF THE SWPPP. SEE SECTION 5 FOR ADDITIONAL REQUIREMENTS.
5. THE CONTRACTOR SHALL PROVIDE A SECONDARY CONTAINMENT PERIMETER AROUND WASTE CONTAINMENT, MATERIAL STORAGE, AND VEHICLE AND EQUIPMENT (FUELING, MAINTENANCE AND STORAGE) AREAS TO CONTAIN LEAKS AND SPILLS AND PREVENT CONTAMINANTS FROM CONTACTING STORM FLOWS.
6. TRACKING CONTROL SHALL BE PROVIDED AT ALL CONSTRUCTION SITE ENTRANCES AND EXITS. THE CONTRACTOR SHALL COORDINATE THE MODIFICATION OF THESE DRAWINGS TO SHOW ACTUAL ENTRANCE/ EXITS USED.
7. THE CONTRACTOR SHALL IMPLEMENT ADEQUATE EROSION AND SEDIMENT CONTROL MEASURES FOR ALL TRENCHING AND STOCKPILING ACTIVITIES. SPOIL PILES SHALL BE PROTECTED WITH EROSION & SEDIMENT CONTROL BMPS. THE CONTRACTOR SHALL IMPLEMENT DEWATERING OPERATIONS PER NS-2 AS NECESSARY.
8. TEMPORARY SOIL STABILIZATION MEASURES WILL BE IMPLEMENTED FOR ALL DISTURBED SOIL AREAS (DSA) WITHIN 14 DAYS OF INACTIVITY.
9. PERMANENT EROSION CONTROL SHALL BE INSTALLED IN AREAS THAT ARE SUBSTANTIALLY COMPLETE. SEDIMENT CONTROL BMPS SHALL BE REMOVED AFTER SOIL IS STABILIZED AND WHEN PERMANENT EROSION CONTROL IS COMPLETE, AS APPROVED BY THE INSPECTOR.
10. THE STORM WATER POLLUTION PREVENTION CONTROL MEASURES SHOWN IN THESE DRAWINGS ARE SUGGESTED BEST MANAGEMENT PRACTICES (BMPs). DIFFERENT CONTROL MEASURES MAY BE NECESSARY TO SATISFY THE REQUIREMENTS OF THE GENERAL PERMIT, BASED ON ACTUAL CONSTRUCTION ACTIVITIES AND FIELD CONDITIONS.
11. BMPS SHOULD BE USED TO SHORTEN SLOPE DISTANCES ON STEEP SLOPES, EXAMPLE AS INDICATED IN TABLE 1.

TABLE 1 - MAXIMUM SLOPE DISTANCE	
SLOPE (V:H)	MAXIMUM SLOPE DISTANCE
≤ 1:20	PER QSD'S SPECIFICATION
> 1:20 TO ≤ 1:4	35 FT
> 1:4 TO ≤ 1:3	20 FT
> 1:3 TO ≤ 1:2	15 FT
> 1:2	10 FT

SHEET INDEX	
SHEET NO.	DESCRIPTION
STORMWATER POLLUTION PREVENTION PLAN	
1	COVER
2	LEGEND AND ABBREVIATIONS
3	NOTES & GENERIC STAGING AREA
4	OVERALL SITE PLAN
5	EXISTING UTILITY CONNECTION
6	SAN LUIS CANAL CROSSING
7	SAN LUIS DRAIN CROSSING
8	SANTA FE CANAL CROSSING
9	WWTP UTILITY CONNECTION
10	SAN LUIS CANAL SIPHON PLAN
11	SAN LUIS CANAL TURNOUT
12	SAN LUIS CANAL OUTLET
13	DETAILS

THIS PLAN ACCURATE FOR STORM WATER POLLUTION CONTROL WORK ONLY

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FOR UPPP PURPOSES ONLY
02/12/2025

No.	REVISION	BY	DATE

REGISTERED PROFESSIONAL ENGINEER — GRETCHEN M. HEISDORF — No. 77241 — STATE OF CALIFORNIA — REVIEW ONLY

SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS
IN MERCED COUNTY
STORMWATER POLLUTION PREVENTION PLAN
COVER

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DESIGN ENGINEER: GRETCHEN HEISDORF
LICENSE NO: RCE 77241, CASQA 00485
DRAFTED BY: GJF | CHECKED BY: GMH
DATE: 02/12/2025
JOB NO: 350123011
PROJECT NO: CLB 2023-019
PHASE:
0 1"
ORIGINAL SCALE SHOWN IS ONE INCH. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.
SHEET 1
OF 5

2/20/2025 3:33 PM g:\los banos_city of-350\350123011-sewer pipeline replacement at wwtp\300 CAD\340 sheet sets\sewer pipeline replacement\UPPP\1 COVER.dwg -Greg Feaver

ABBREVIATIONS

AB	AGGREGATE BASE
AC	ASPHALT CONCRETE
ACP	ASBESTOS-CEMENT PIPE
AGG	AGGREGATE
APN	ASSESSOR'S PARCEL NUMBER
AVE	AVENUE
BTM	BOTTOM
BWR	BARB WIRE
C, CONC	CONCRETE
CA	CALIFORNIA
CLVT	CULVERT
CL	CENTERLINE
CLF	CHAIN LINK FENCE
CNS	COMPACTED NATIVE SOIL
CONT	CONTINUOUS
CONST	CONSTRUCT/CONSTRUCTION
CP	CULVERT PROTECTION
CR	CROWN
D/S	DOWNSTREAM
(E)	EXISTING
EG	EXISTING GRADE
EL, ELEV	ELEVATION
ELEC	ELECTRIC
EP	EDGE OF PAVEMENT
ESMT	EASEMENT
ES	EROSION/SEDIMENT CONTROL
FF	FINISHED FLOOR
FG	FINISHED GRADE
FL	FLOW LINE
FNC	FENCE
FR	FIBER ROLL
GB	GRADE BREAK
GM	GAS METER
GRVL	GRAVEL
GUY	GUY WIRE
GV	GATE VALVE
HGL	HYDRAULIC GRADE LINE
HP	HINGE POINT, HIGH POINT
HP GAS	HIGH PRESSURE GAS
HWL	HIGH WATER LEVEL
IRR	IRRIGATION
IP	INLET PROTECTION
MAX	MAXIMUM
MIN	MINIMUM
MISC	MISCELLANEOUS
NTS	NOT TO SCALE
OC	ON CENTER
OH	OVERHEAD
(P)	PROPOSED
PL	PROPERTY LINE
PP	POWER POLE
PVMT	PAVEMENT
R/W	RIGHT OF WAY
S=	SLOPE
SF	SILT FENCE
STRC	STRUCTURE
SWL	SWALE
STWL	STILLING WELL
TB	TOP OF BANK
TOE	TOE OF SLOPE
TOP	TOP OF SLOPE
TP	TELEPHONE POLE
TS	TOP OF STRUCTURE
TYP	TYPICAL
U/S	UPSTREAM
VERT	VERTICAL
W	WATER
WV	WATER VALVE

LINETYPES

LINETYPE EXISTING	LINETYPE NEW	DESCRIPTION
		WATER LEVEL
		BARRICADE
		CONTOUR (DEPRESSION)
123	123	CONTOUR (MAJOR)
		CONTOUR (MINOR)
		EMBANKMENT TOE
		EMBANKMENT TOP
		FENCE (BLOCK WALL)
		FENCE (CHAIN LINK)
		FENCE (WOOD)
		FENCE (WIRE)
		GATE SWING
		GRADE BREAK
FL	FL	SWALE CENTERLINE
		SWALE W/FLOW ARROWS
OE	OE	ELECTRIC (AERIAL)
UE	UE	ELECTRIC (BURIED)
G	G	GAS
		CENTERLINE
		EASEMENT
		PROPERTY LINE
		RIGHT-OF-WAY
		SECTION LINE
		STATE/COUNTY/CORPORATE LIMIT
		ROLLING DIP PER USFS SPECIFICATION (SPACING PER USFS)
		SWPPP PIPELINE AND/OR SLOPE DRAIN
		BERM WITH DRAIN SYSTEM
	FR	FIBER ROLL
SF	SF	FENCE (SILT)
EC	EC	LINEAR EROSION CONTROL

HATCHES

EXISTING	NEW	DESCRIPTION	NEW	DESCRIPTION
		AGGREGATE		TRAVEL PATH
		AC PAVEMENT		DEMOLITION
		CONCRETE		EQUIPMENT/MAINTENANCE AREAS (CONTRACTOR TO VERIFY LOCATION)
		CONCRETE LINING (PLAN VIEW)		BMP: TRACKOUT DEVICE (CONTRACTOR TO VERIFY LOCATION)
		EARTH		BMP: MATERIAL STORAGE (CONTRACTOR TO VERIFY LOCATION)
		RIP RAP		BMP: CONCRETE WASTE MANAGEMENT (CONTRACTOR TO VERIFY LOCATION)
		SAND		BMP: ASPHALT CONCRETE STOCKPILE MANAGEMENT (CONTRACTOR TO VERIFY LOCATION)
		GRATING		BMP: SOIL STOCKPILE MANAGEMENT (CONTRACTOR TO VERIFY LOCATION)

SYMBOLS

SYMBOL EXISTING	SYMBOL NEW	DESCRIPTION
		UTILITY POLE
		UTILITY POLE ANCHOR
		2-NOZZLE HYDRANT
		3-NOZZLE HYDRANT
FD	FD	FIRE DEPT. CONNECTION
F	F	FIRE VAULT
		WATER METER
W	W	WELL
		WATER VALVE
		BLOW-OFF
		AIR RELIEF VALVE
BFP	BFP	BACK FLOW PREVENTOR
		GATE VALVE HANDLE
		STILLING WELL
		FENCE POST
		FENCE GATE
	XX	REVISION
	X	CONSTRUCTION CALLOUT
XX / XXXX	DETAIL NUMBER / SHEET NUMBER	DETAIL CALLOUT
		LINE BREAK
		SPILL KIT
		DRAINAGE DIRECTION
E		CONSTRUCTION SITE ENTRANCE/EXIT, TRACKOUT LOCATION
		EMBANKMENT ARROW
HWL= XXX.XX		HIGH WATER LINE
XXX.X± FG MATCH (E)	SPOT ELEVATION DESCRIPTION	SPOT ELEVATION
		SECTION VIEW
SF ES FR		BMP: EROSION & SEDIMENT CONTROL BARRIER AND WIND EROSION CONTROL MEASURES PER BMP HANDBOOK (CONTRACTOR TO VERIFY LOCATION)
		SEDIMENT BASIN; LOCATION & DESIGN PER CONSTRUCTION PLAN SET
CP IP		BMP: STORM DRAIN INLET/CULVERT PROTECTION PER BMP HANDBOOK
S#		TENTATIVE SAMPLING LOCATION (TO BE FIELD DETERMINED)
D#		POTENTIAL DISCHARGE LOCATION (TO BE FIELD DETERMINED)

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02/12/2025

No.	REVISION	BY	DATE

REGISTERED PROFESSIONAL ENGINEER — GRETCHEN M. HEISDORF — No. RCE 77241 — STATE OF CALIFORNIA — REVIEW ONLY

SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS
IN MERCED COUNTY
STORMWATER POLLUTION PREVENTION PLAN
LEGEND AND ABBREVIATIONS

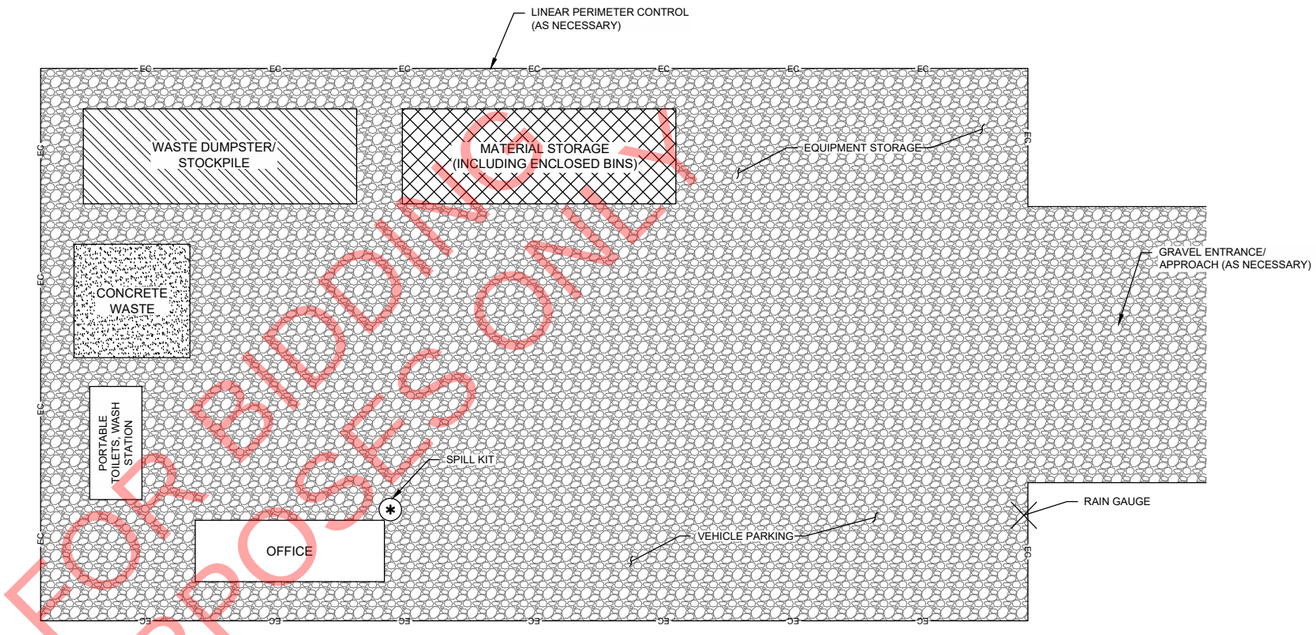
PROVOST & PRITCHARD
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www.provostandpritchard.com

DESIGN ENGINEER: GRETCHEN HEISDORF
LICENSE NO: RCE 77241, CASQA 00485
DRAFTED BY: GJF | CHECKED BY: GMH
DATE: 02/12/2025
JOB NO: 350123011
PROJECT NO: CLB 2023-019
PHASE:
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ORIGINAL SCALE SHOWN IS ONE INCH. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.
SHEET 2
OF 5

2/20/2025 3:33 PM g:\los banos_city of-350\350123011-sewer pipeline replacement at swtp\300 CAD\340 sheet sets\sewer pipeline replacement\UPPP\2 LEGEND AND ABBREVIATIONS.dwg -Greg Feaver

NOTES

1. ALL CONSTRUCTION SHALL BE IN ACCORDANCE WITH THE CONSTRUCTION CONTRACT DOCUMENTS.
2. SWPPP BMP IMPLEMENTATION SHALL MEET THE MINIMUMS REQUIRED BY THE SWPPP.
3. CONTRACTOR IS RESPONSIBLE FOR THE IMPLEMENTATION OF ALL STORMWATER AND NON-STORMWATER POLLUTION PREVENTION PRACTICES REGARDLESS OF INCLUSION IN THESE SITE MAPS OR IN THE PROJECT SWPPP.
4. CONTRACTOR SHALL USE THESE DRAWINGS FOR ANY CHANGES TO THE SWPPP.
5. CONTRACTOR SHALL LIMIT GROUND DISTURBANCES AT ALL TIMES TO THE MAXIMUM EXTENT FEASIBLE TO ACCOMPLISH WORK. ALL GROUND DISTURBANCES REQUIRE EROSION AND SEDIMENT CONTROL MITIGATIONS.
6. CONTRACTOR IS RESPONSIBLE FOR PROVIDING ADEQUATE DUST CONTROL AT ALL TIMES.
7. THE CONTRACTOR SHALL HAVE A SECURE ONSITE LOCATION FOR SWPPP AND ENVIRONMENTAL DOCUMENT STORAGE.
8. DO NOT BLOCK DRIVEWAYS OR ENTRANCE LOCATIONS WITH ANY BMP ITEMS.
9. CONTRACTOR IS RESPONSIBLE FOR ALL STORMWATER AND NON-STORMWATER, VISIBLE AND NON-VISIBLE SAMPLING.
10. ALL DEMOLITION SHALL BE IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REGULATIONS.
11. CONTRACTOR SHALL PROVIDE INLET AND/OR CULVERT PROTECTION AT INLETS/CULVERTS WITHIN AND IMMEDIATELY DOWNSTREAM OF PROJECT SITE(S), REGARDLESS OF SPECIFIC INCLUSION ON THESE DRAWINGS.
12. TRACKOUT ONTO PUBLIC ROADS IS PROHIBITED AND MUST BE CLEANED IMMEDIATELY VIA HAND OR MECHANICAL MEANS. GRAVEL TRACKOUT IN ACCORDANCE WITH CASQA BMP TC-1 IS REQUIRED AT ALL EXIT LOCATIONS TO THE PROJECT AREA(S) TO PUBLIC ROADS PER THE SWPPP REGARDLESS OF SPECIFIC INCLUSION IN THESE DRAWINGS.
13. BULK MATERIAL STORAGE WILL BE IN THE STAGING AREA(S) OR IN OTHER OWNER APPROVED LOCATIONS. ALL MATERIAL STORAGE WILL BE IN ACCORDANCE WITH CASQA BMPS WM-1 AND WM-3.
14. SOIL/MATERIAL STOCKPILES WILL BE COVERED WITH VISQUEEN AND LINEAR CONTROLS INSTALLED PER CASQA BMP WM-3.
15. ALL EXCESS ERODIBLE OR NON-FINAL STATE CONSTRUCTION MATERIALS SHALL BE REMOVED FROM THE SITE OR HOUSED IN WATERTIGHT ENCLOSURES, INCLUDING SOIL/OVERBURDEN AND DEBRIS.
16. CONCRETE DEMOLITION, INSTALLATION, AND/OR WASTES REQUIRE CASQA BMPS WM-8, WM-3, NS-12, AND NS-13 REGARDLESS OF SPECIFIC INCLUSIONS ON THESE DRAWINGS. MOBILE CONCRETE WASHOUTS ARE ACCEPTABLE & TO BE LOCATED BY THE CONTRACTOR. WASHOUTS WILL BE CLEANED/CLEARED OF WASTE CONCRETE PRIOR TO OVERTOPPING. LIQUID DECANT IS CONSIDERED A WASTE PRODUCT AND MUST BE DISPOSED OF PROPERLY IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REQUIREMENTS. IT CAN NOT BE USED FOR DUST CONTROL.
17. ALL CHEMICAL ADDITIVES (CURING COMPOUNDS) WILL NOT BE APPLIED WITHIN 48 HOURS OF A PREDICTED RAIN EVENT UNLESS THE AFFECTED AREA IS FULLY COVERED AND SEALED FROM EXPOSURE TO PRECIPITATION. EPOXY USE WILL NOT OCCUR WITHIN 48 HOURS OF A PREDICTED RAIN EVENT UNLESS THE AFFECTED AREA IS FULLY COVERED AND SEALED FROM EXPOSURE TO PRECIPITATION.
18. TREATED LUMBER PRODUCTS, METAL PRODUCTS, PLASTICS, PAINT, EPOXY, AND OTHER MATERIALS SHALL BE USED IN SUCH A MANNER AS TO NOT INTRODUCE POLLUTANTS TO ANY DISCHARGE. ANY WASTES OR SPILLS SHALL BE CLEANED IMMEDIATELY.
19. VEHICLES & EQUIPMENT SHALL BE STORED IN THE STAGING AREA WHEN NOT IN USE & OVERNIGHT. WHILE IN USE, VEHICLES & EQUIPMENT SHALL BE MONITORED TO PREVENT SPILLS OR LEAKS. VEHICLES & EQUIPMENT, WHILE STORED, SHALL BE MONITORED AT START & END OF DAY FOR SPILLS OR LEAKS.
20. PORTABLE TOILETS/SANITARY STATIONS AND WASH STATIONS SHALL BE LOCATED ON A FLAT SURFACE WITHIN SECONDARY CONTAINMENT.
21. FUELING SPILL KITS WILL BE MAINTAINED ON THE FUELING TRUCK AND A SPILL KIT WILL BE KEPT ONSITE AT THE ACTIVE CONSTRUCTION AREA(S) DURING WORK HOURS.
22. SAMPLING AND MONITORING MAY TAKE PLACE IN VARIOUS LOCATIONS TO BE DETERMINED BY THE QSP WITHIN THE PROJECT AREA(S) TO ENSURE CONSTRUCTION ACTIVITIES ARE NOT CAUSING PROJECT SITE DISCHARGES. SAMPLING SHALL BE IN ACCORDANCE WITH SECTION 5 OF THE SWPPP AND SAMPLING SHALL INCLUDE ALL APPLICABLE CONSTITUENTS BASED ON CONSTRUCTION ACTIVITIES.
23. NO MATERIALS OR CONSTRUCTION EQUIPMENT SHALL BE STORED ONSITE THROUGH THE PRE-DETERMINED SITE SHUTDOWNS FOR WEATHER UNLESS IT IS STORED IN AN ENCLOSED, WEATHERPROOF ENCLOSURE.
24. INTERIM STABILIZATION MEASURES DURING SITE SHUTDOWNS WILL INCLUDE IMPERVIOUS COVERS, ENCLOSED STORAGE, NON-SEEDED TACKIFIER USES, ETC. ALL INTERIM STABILIZATION MEASURES MUST BE APPROVED BY THE OWNER AND ENGINEER.
25. BMP GUIDANCE SHEETS ARE AVAILABLE FROM WWW.CASQA.COM.



GENERIC STAGING AREA

NTS

NOTES

1. ALL EQUIPMENT SHALL BE STORED ON AN IMPERVIOUS SURFACE WITH ADEQUATE SECONDARY CONTAINMENT.
2. ALL FUELING SHALL INCLUDE THE USE OF DRIP PANS AND RAGS REGARDLESS OF LOCATION. A SPILL KIT SHALL BE IN THE IMMEDIATE VICINITY DURING FUELING.
3. STAGING AREA(S) WILL INCLUDE, BUT WILL NOT BE LIMITED TO, PERVIOUS CONSTRUCTED SURFACES (GRAVEL OR HARD PACKED EARTH), LINEAR PERIMETER CONTROLS, VEHICLE AND EQUIPMENT CLEANING, FUELING, AND MAINTENANCE CONTROLS (INCLUDING IMPERVIOUS SURFACING), WASTE MANAGEMENT CONTROLS, CONCRETE WASTE MANAGEMENT CONTROLS, HAZARDOUS/NON-HAZARDOUS CHEMICAL/MATERIAL CONTAINMENT CONTROLS, SEDIMENT AND EROSION CONTROLS, AND SANITARY, WASH WATER, AND LIQUID WASTE CONTROLS.
4. LOCATE RAIN GAUGE IN AN OPEN AREA WITH EASY ACCESS FOR MEASUREMENT READING AND GAUGE MAINTENANCE.
5. IF PROJECT OFFICE IS LOCATED IN THE STAGING AREA, MAINTAIN APPROPRIATE SWPPP AND ENVIRONMENTAL DOCUMENTATION INSIDE.

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SEWER PIPELINE REPLACEMENT

CITY OF LOS BANOS
IN MERCED COUNTY

STORMWATER POLLUTION PREVENTION PLAN

NOTES & GENERIC STAGING AREA

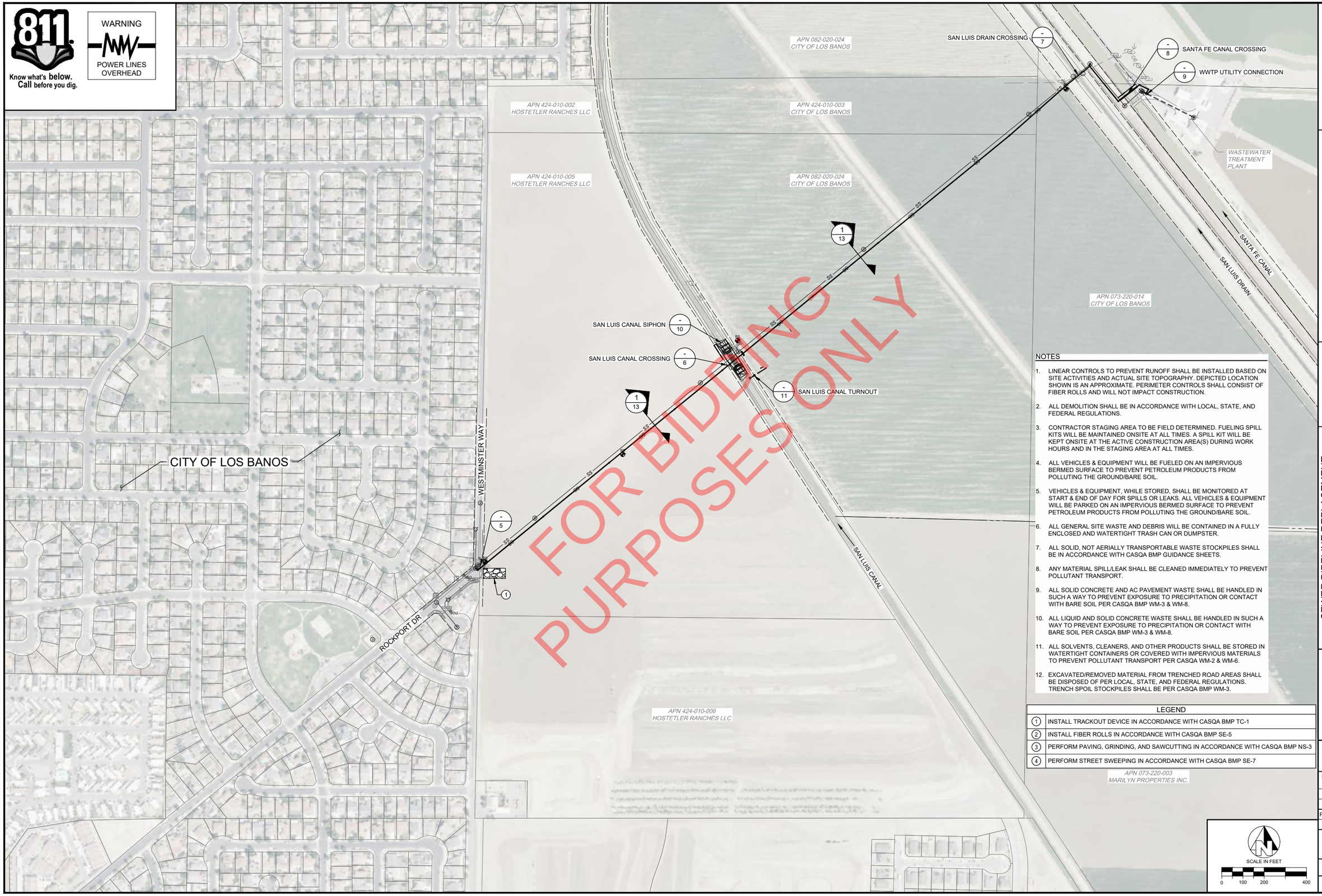
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SHEET 3
OF 5

2/20/2025 3:33 PM g:\los banos_city of-350\350123011-sewer pipeline replacement at ww\p300 CAD\340 sheet sets\sewer pipeline replacement\UPPP\3 NOTES & GENERIC STAGING AREA.dwg -Greg Feaver

811
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WARNING
POWER LINES OVERHEAD



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12. EXCAVATED/REMOVED MATERIAL FROM TRENCHED ROAD AREAS SHALL BE DISPOSED OF PER LOCAL, STATE, AND FEDERAL REGULATIONS. TRENCH SPOIL STOCKPILES SHALL BE PER CASQA BMP WM-3.

LEGEND	
1	INSTALL TRACKOUT DEVICE IN ACCORDANCE WITH CASQA BMP TC-1
2	INSTALL FIBER ROLLS IN ACCORDANCE WITH CASQA BMP SE-5
3	PERFORM PAVING, GRINDING, AND SAWCUTTING IN ACCORDANCE WITH CASQA BMP NS-3
4	PERFORM STREET SWEEPING IN ACCORDANCE WITH CASQA BMP SE-7

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GRETCHEN J. HEISDORF
No. RCE 77241
STATE OF CALIFORNIA
REVIEW

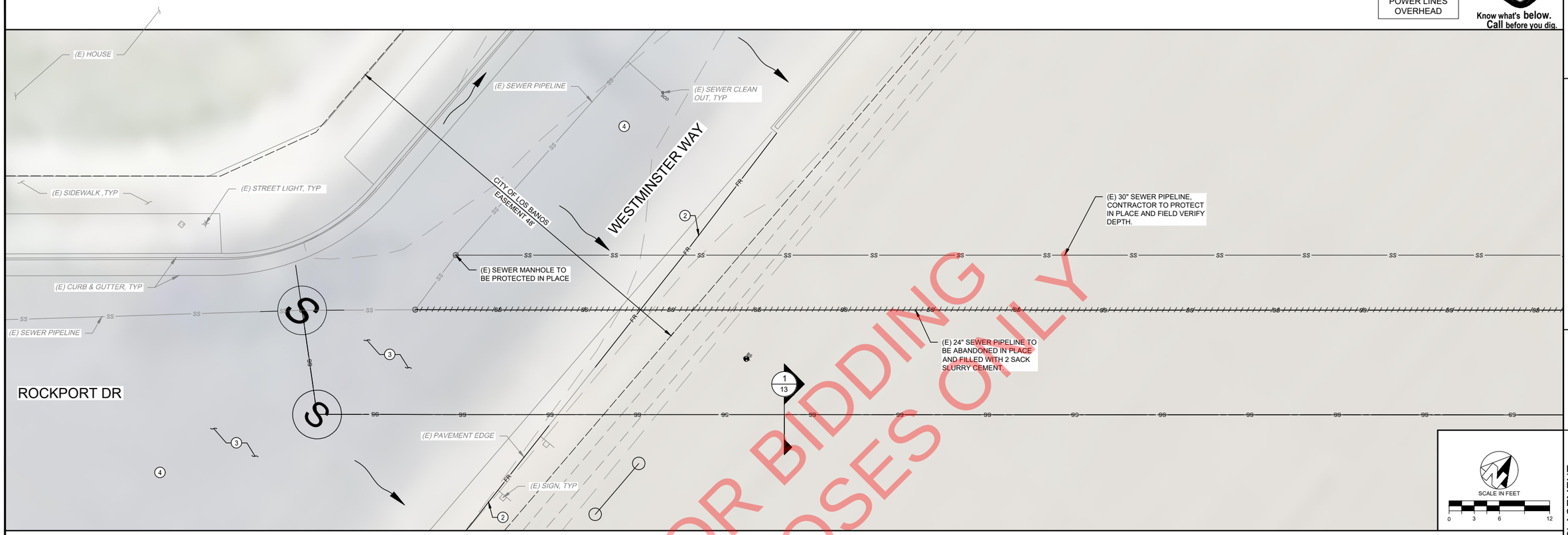
SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS
IN MERCED COUNTY
STORMWATER POLLUTION PREVENTION PLAN

OVERALL SITE PLAN

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SHEET 4
OF 5

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WARNING
POWER LINES OVERHEAD

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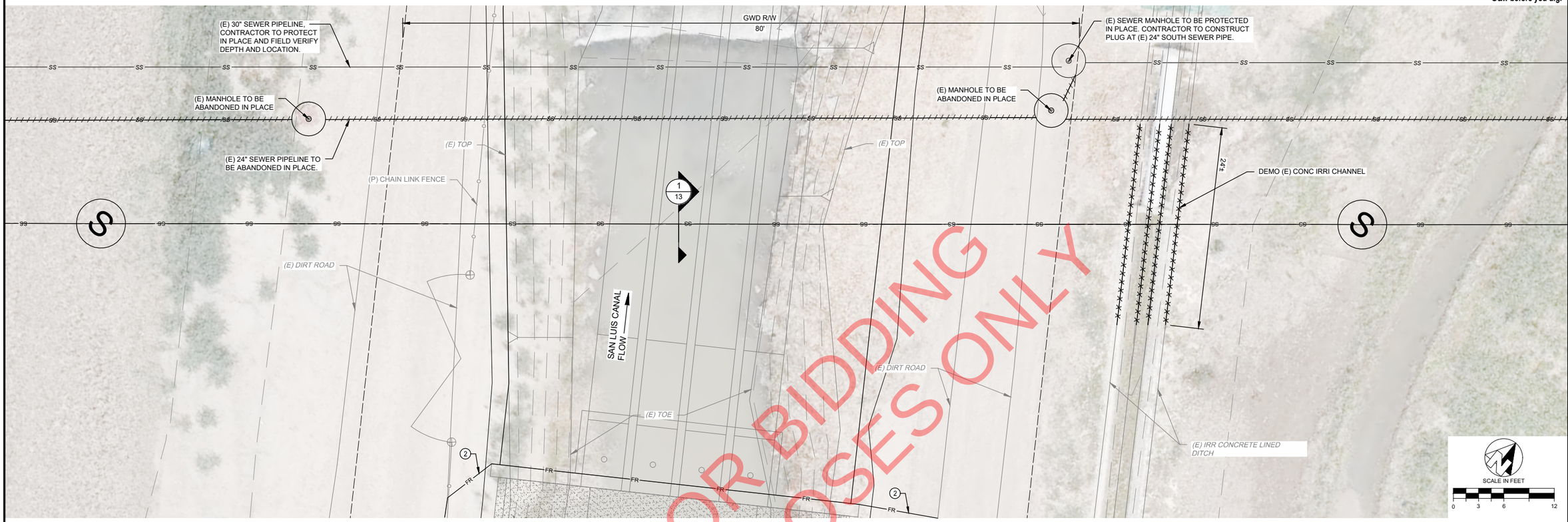
REGISTERED PROFESSIONAL ENGINEER ★ GRETCHEN J. HEISDORF ★ STATE OF CALIFORNIA
REVIEW ONLY

SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS
IN MERCED COUNTY
STORMWATER POLLUTION PREVENTION PLAN
EXISTING UTILITY CONNECTION

PROVOST & PRITCHARD
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SHEET 5
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SAN LUIS CANAL CROSSING

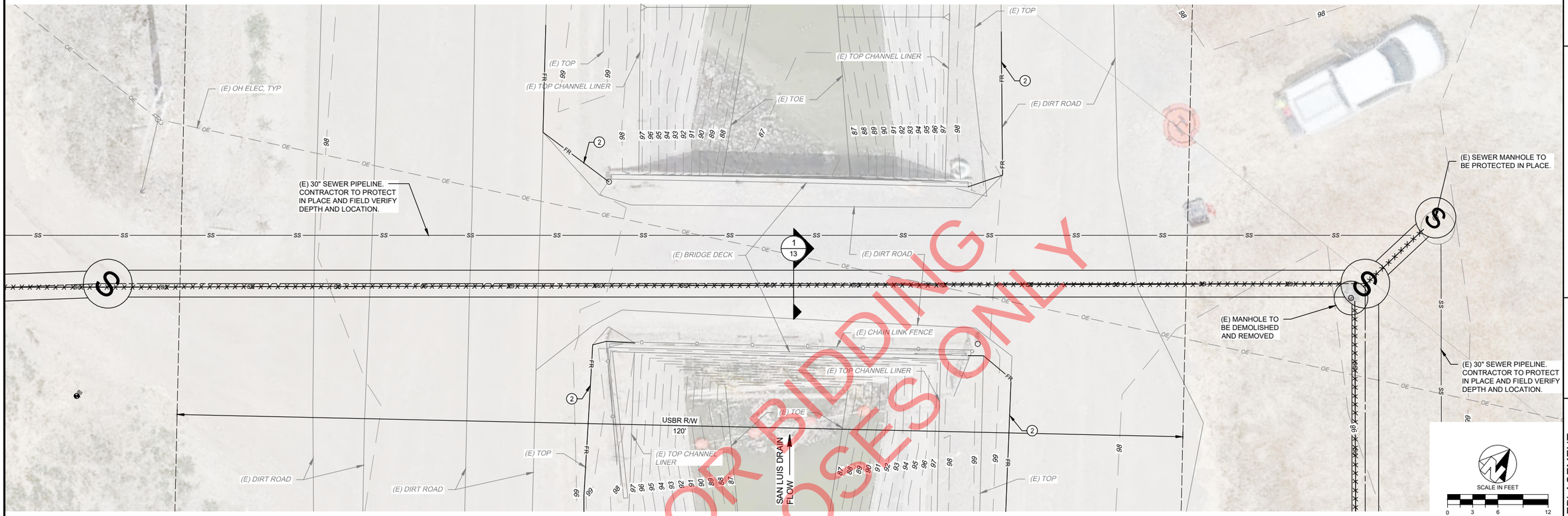
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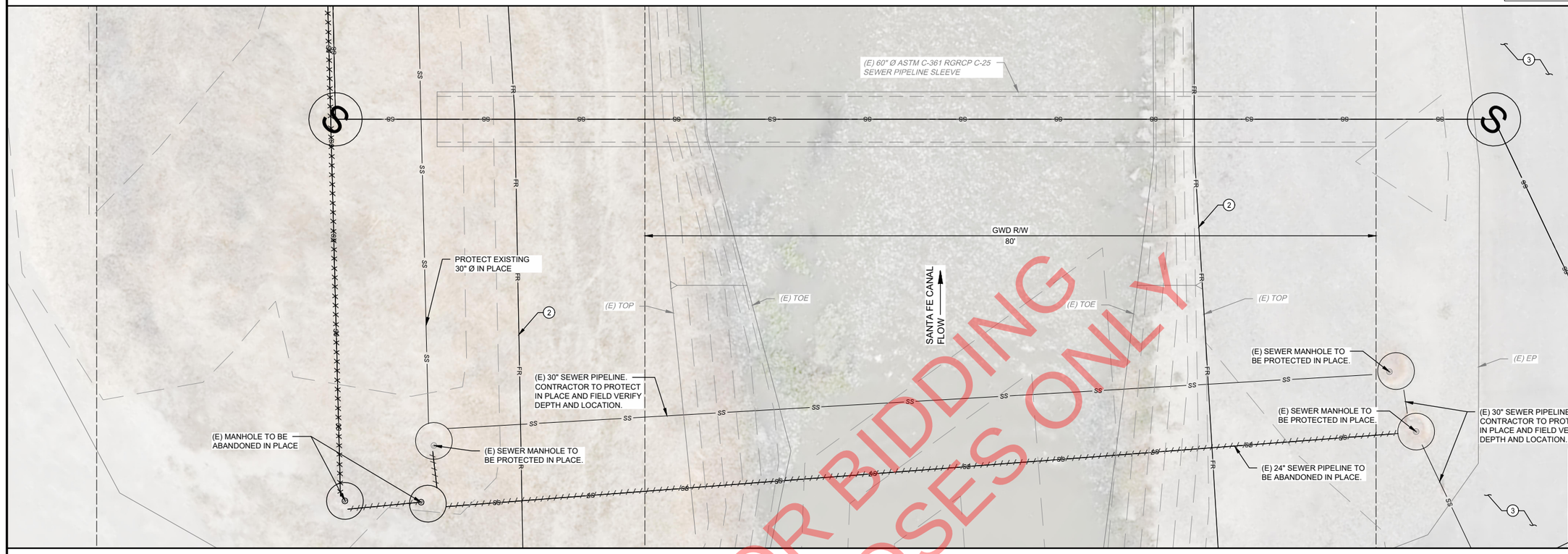
REGISTERED PROFESSIONAL ENGINEER — GRETCHEN JOY HEISDORF — No. RCE 77241 — STATE OF CALIFORNIA — FOR REVIEW ONLY

SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS
IN MERCED COUNTY
STORMWATER POLLUTION PREVENTION PLAN
SAN LUIS DRAIN CROSSING

PROVOST & PRITCHARD
249 W. PACHECO BLVD, SUITE B
LOS BANOS, CALIFORNIA 93635
PHONE (209) 826-9696
FAX (209) 829-1075
www.provostandpritchard.com

DESIGN ENGINEER: GRETCHEN HEISDORF
LICENSE NO: RCE 77241, CASQA 00485
DRAFTED BY: GJF | CHECKED BY: GMH
DATE: 02/12/2025
JOB NO: 350123011
PROJECT NO: CLB 2023-019
PHASE:
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ORIGINAL SCALE SHOWN IS ONE INCH. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.
SHEET 7
OF 5

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REGISTERED PROFESSIONAL ENGINEER — GRETCHEN J. FEAVER — No. RCE 77241 — STATE OF CALIFORNIA — FOR REVIEW ONLY

SEWER PIPELINE REPLACEMENT

CITY OF LOS BANOS
IN MERCED COUNTY

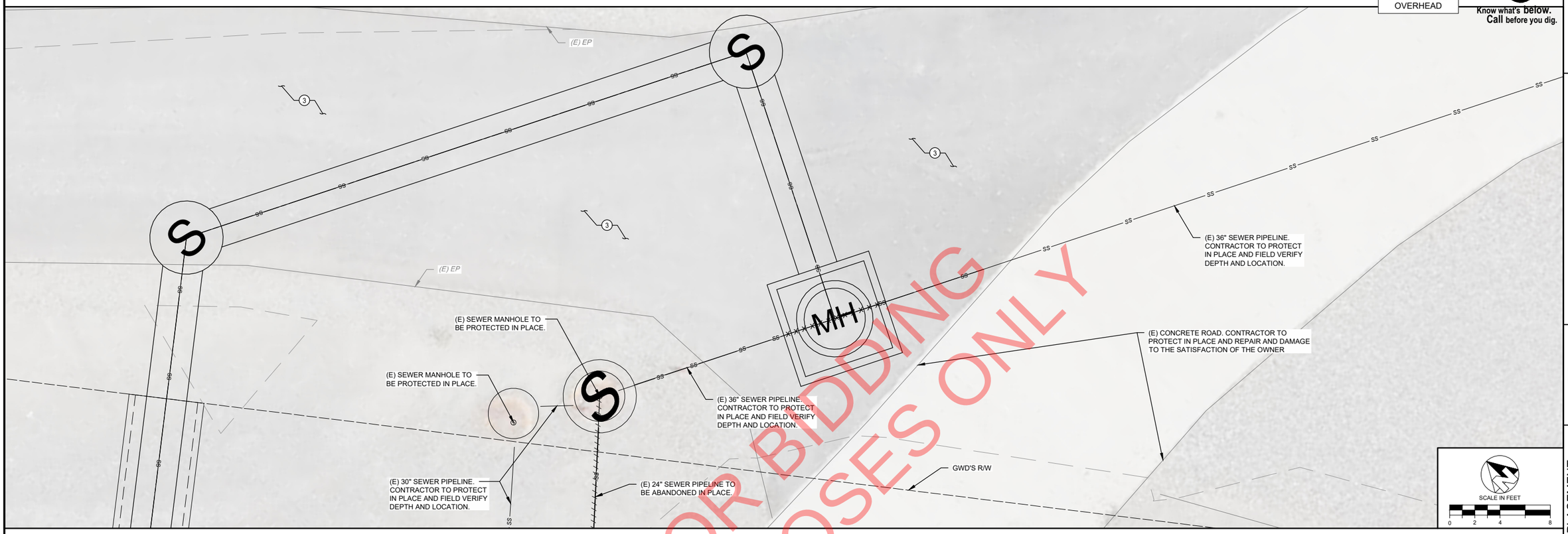
STORMWATER POLLUTION PREVENTION PLAN

SANTA FE CANAL CROSSING

PROVOST & PRITCHARD
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www.provostandpritchard.com

DESIGN ENGINEER: GRETCHEN HEISDORF
LICENSE NO: RCE 77241, CASQA 00485
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DATE: 02/12/2025
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SHEET 8
OF 5

2/20/2025 3:38 PM g:\los banos_city of-350\350123011-sewer pipeline replacement at ww\p300 CAD\340 sheet sets\sewer pipeline replacement\UPPP\8 SANTA FE CANAL CROSSING.dwg -Greg Feaver



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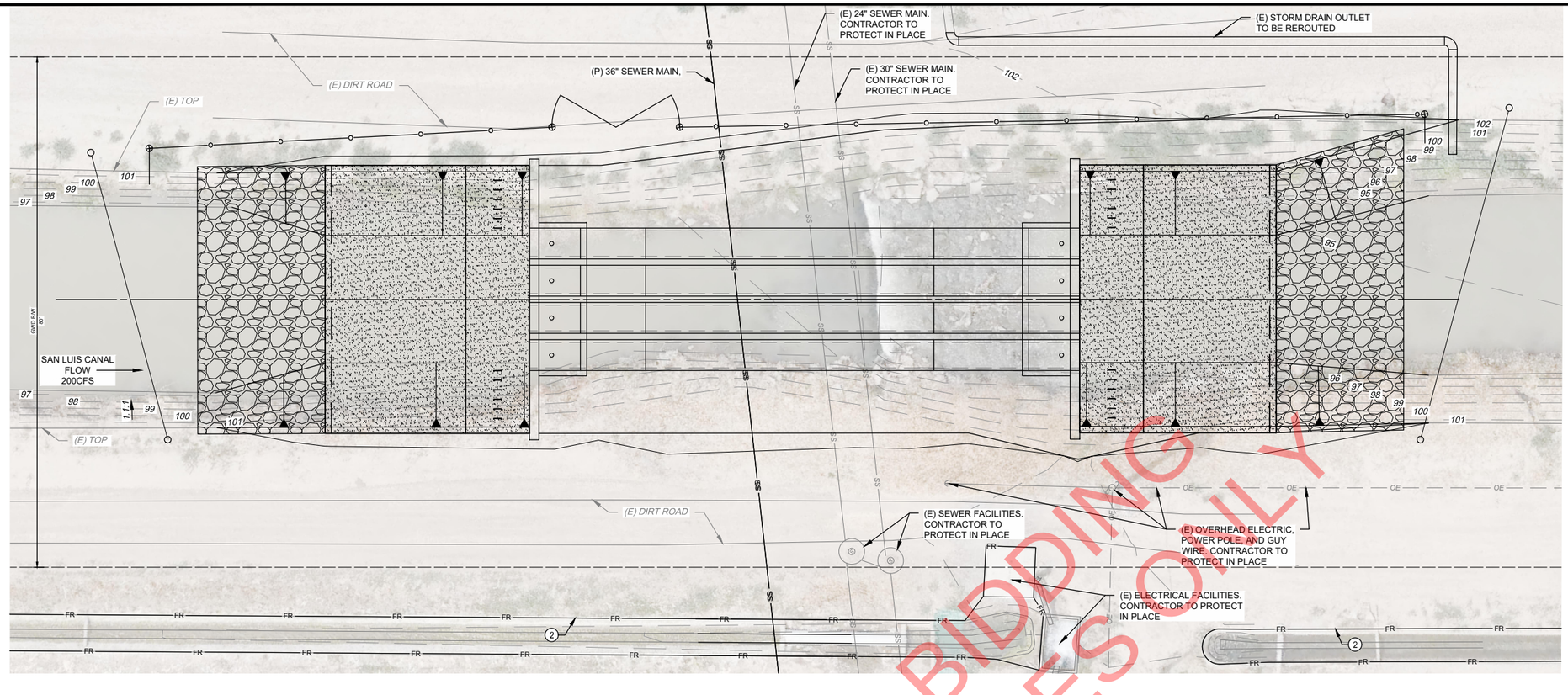
REGISTERED PROFESSIONAL ENGINEER
GRETCHEN JOY HEISDORF
No. RCE 77241
STATE OF CALIFORNIA
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SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS
IN MERCED COUNTY
STORMWATER POLLUTION PREVENTION PLAN
WWTP UTILITY CONNECTION

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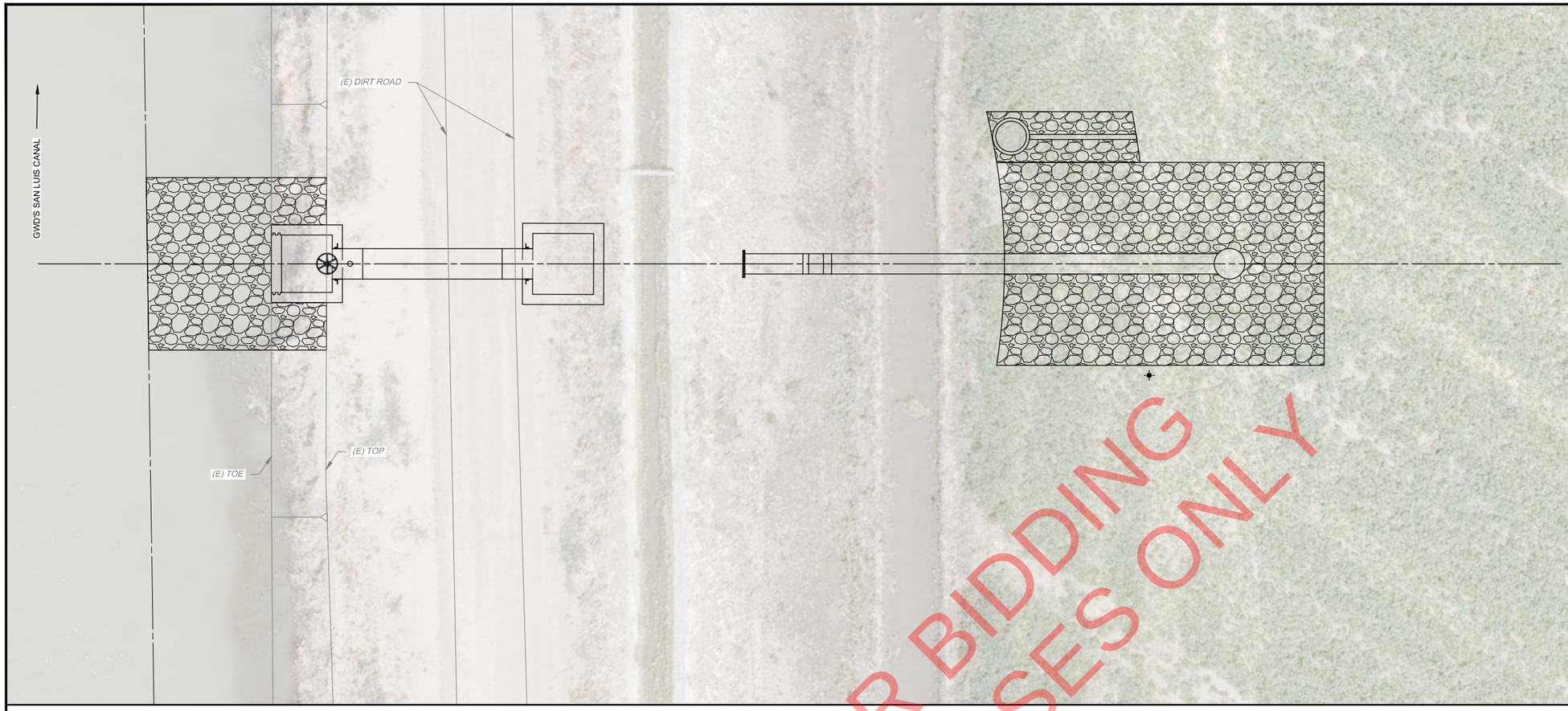
REGISTERED PROFESSIONAL ENGINEER ★ GRETCHEN M. HEISDORF ★ No. RCE 77241 ★ STATE OF CALIFORNIA ★ REVIEW

SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS
IN MERCED COUNTY
STORMWATER POLLUTION PREVENTION PLAN
SAN LUIS CANAL SIPHON
PLAN

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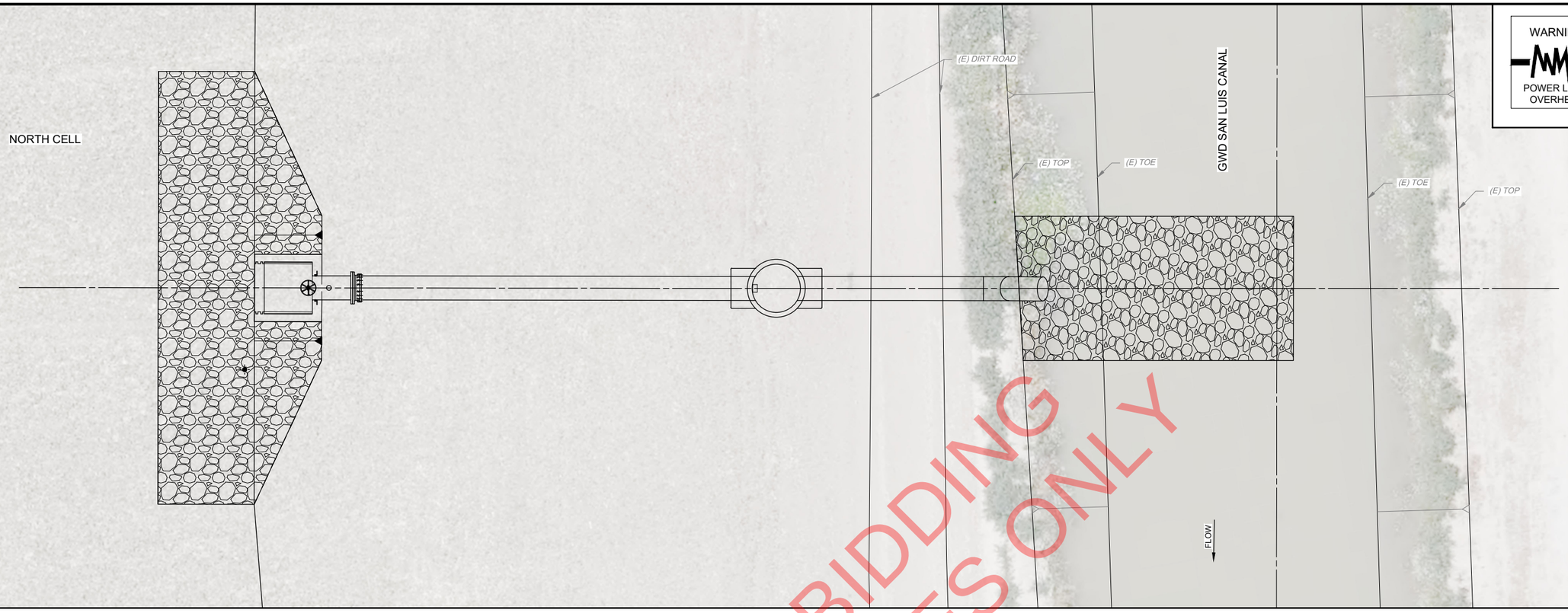
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1. ALL WORK TO BE COMPLETED IN THE GRASSLAND WATER DISTRICT CANAL IS TO BE COMPLETED WHILE THE CANAL IS DRY. IN THE EVENT THE CANAL HAS WATER PRESENT, ADDITIONAL POLLUTION PREVENTION MEASURES WILL BE REQUIRED.
2. LINEAR CONTROLS TO PREVENT RUNOFF SHALL BE INSTALLED BASED ON SITE ACTIVITIES AND ACTUAL SITE TOPOGRAPHY. DEPICTED LOCATION SHOWN IS AN APPROXIMATE. PERIMETER CONTROLS SHALL CONSIST OF FIBER ROLLS AND WILL NOT IMPACT CONSTRUCTION.
3. ALL DEMOLITION SHALL BE IN ACCORDANCE WITH LOCAL, STATE, AND FEDERAL REGULATIONS.
4. CONTRACTOR STAGING AREA TO BE FIELD DETERMINED. FUELING SPILL KITS WILL BE MAINTAINED ONSITE AT ALL TIMES. A SPILL KIT WILL BE KEPT ONSITE AT THE ACTIVE CONSTRUCTION AREA(S) DURING WORK HOURS AND IN THE STAGING AREA AT ALL TIMES.
5. ALL VEHICLES & EQUIPMENT WILL BE FUELED ON AN IMPERVIOUS BERMED SURFACE TO PREVENT PETROLEUM PRODUCTS FROM POLLUTING THE GROUND/BARE SOIL.
6. VEHICLES & EQUIPMENT, WHILE STORED, SHALL BE MONITORED AT START & END OF DAY FOR SPILLS OR LEAKS. ALL VEHICLES & EQUIPMENT WILL BE PARKED ON AN IMPERVIOUS BERMED SURFACE TO PREVENT PETROLEUM PRODUCTS FROM POLLUTING THE GROUND/BARE SOIL.
7. ALL GENERAL SITE WASTE AND DEBRIS WILL BE CONTAINED IN A FULLY ENCLOSED AND WATERTIGHT TRASH CAN OR DUMPSTER.
8. ALL SOLID, NOT AERIALLY TRANSPORTABLE WASTE STOCKPILES SHALL BE IN ACCORDANCE WITH CASQA BMP GUIDANCE SHEETS.
9. ALL SOLVENTS, CLEANERS, AND OTHER PRODUCTS SHALL BE STORED IN WATERTIGHT CONTAINERS OR COVERED WITH IMPERVIOUS MATERIALS TO PREVENT POLLUTANT TRANSPORT PER CASQA WM-2 & WM-6.
10. ANY MATERIAL SPILL/LEAK SHALL BE CLEANED IMMEDIATELY TO PREVENT POLLUTANT TRANSPORT.
11. ALL SOLID CONCRETE AND AC PAVEMENT WASTE SHALL BE HANDLED IN SUCH A WAY TO PREVENT EXPOSURE TO PRECIPITATION OR CONTACT WITH BARE SOIL PER CASQA BMP WM-3 & WM-8.
12. ALL LIQUID AND SOLID CONCRETE WASTE SHALL BE HANDLED IN SUCH A WAY TO PREVENT EXPOSURE TO PRECIPITATION OR CONTACT WITH BARE SOIL PER CASQA BMP WM-3 & WM-8.
13. EXCAVATED/REMOVED MATERIAL FROM TRENCHED AREAS SHALL BE DISPOSED OF PER LOCAL, STATE, AND FEDERAL REGULATIONS. TRENCH SPOIL STOCKPILES SHALL BE PER CASQA BMP WM-3.

LEGEND	
1	INSTALL TRACKOUT DEVICE IN ACCORDANCE WITH CASQA BMP TC-1
2	INSTALL FIBER ROLLS IN ACCORDANCE WITH CASQA BMP SE-5
3	PERFORM PAVING, GRINDING, AND SAWCUTTING IN ACCORDANCE WITH CASQA BMP NS-3
4	PERFORM STREET SWEEPING IN ACCORDANCE WITH CASQA BMP SE-7

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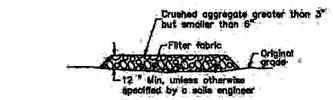
SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS
IN MERCED COUNTY
STORMWATER POLLUTION PREVENTION PLAN
SAN LUIS CANAL OUTLET

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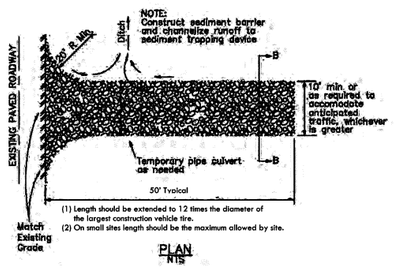
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LICENSE NO: RCE 77241, CASQA 00485
DRAFTED BY: GJF | CHECKED BY: GMH
DATE: 02/12/2025
JOB NO: 350123011
PROJECT NO: CLB 2023-019
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ORIGINAL SCALE SHOWN IS ONE INCH. ADJUST SCALE FOR REDUCED OR ENLARGED PLANS.
SHEET 12
OF 5

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Stabilized Construction Entrance/Exit TC-1



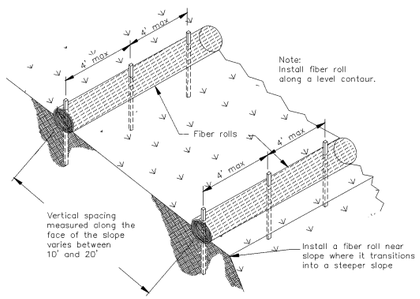
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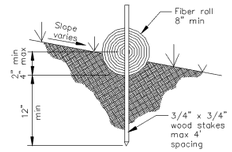
PLAN
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Detail is from SWPPP Appendix - BMP Guidance Fact Sheets and does not supersede any specifications elsewhere in the SWPPP or SWPPP

Fiber Rolls SE-5



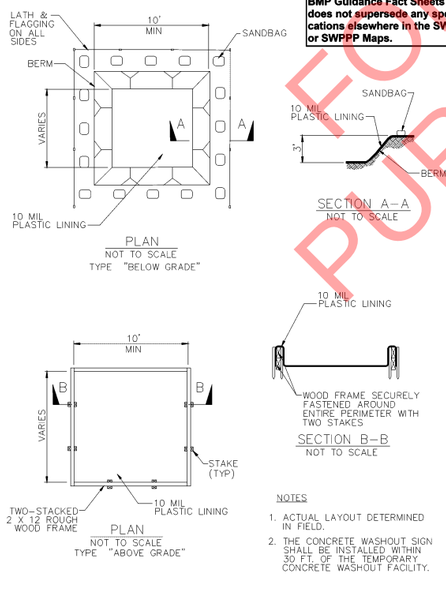
TYPICAL FIBER ROLL INSTALLATION
N.T.S.



ENTRENCHMENT DETAIL
N.T.S.

Detail is from SWPPP Appendix - BMP Guidance Fact Sheets and does not supersede any specifications elsewhere in the SWPPP or SWPPP

Concrete Waste Management WM-8



Detail is from SWPPP Appendix - BMP Guidance Fact Sheets and does not supersede any specifications elsewhere in the SWPPP or SWPPP Maps.

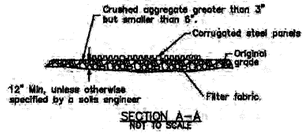
NOTES

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

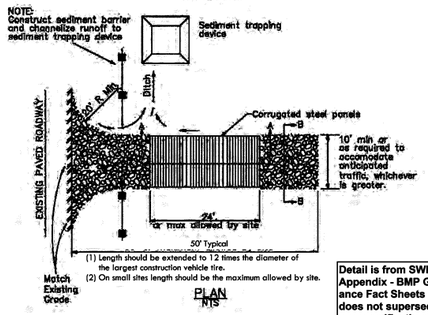
Stabilized Construction Entrance/Exit TC-1



SECTION B-B
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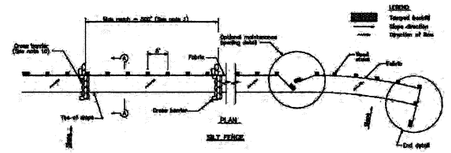
SECTION A-A
NOT TO SCALE



PLAN
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Silt Fence SE-1

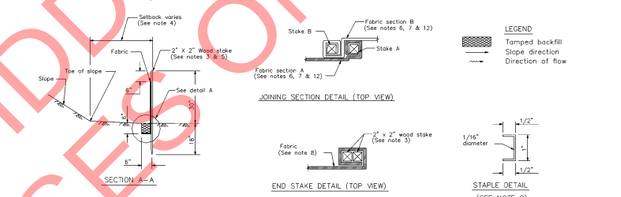


NOTES

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 barrier. In no case shall any reach have length exceed 500'.
2. The last 8'-0" of fence shall be turned up slope.
3. Stake dimensions are nominal.
4. Dimensions may vary to fit field conditions.
5. Stakes shall be spaced at 8'-0" maximum and shall be positioned on downstream side of fence.
6. Fasten by sewing and fence fabric to the upslope post sections 3/4 inch. Secure fabric to stake with 4 staples.
7. Stakes shall be driven tightly together to prevent potential gaps through of material at joint. The tops of the stakes shall be secured with wire.
8. For end stakes, fence fabric shall be folded around the stake 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 24 1/2 and a maximum of 1/2 the height of the slope barrier.
11. Sediment deposits exciting shall be maintained in a manner to ensure sediment remains behind silt fence.
12. Joining sections shall not be placed at sump locations.
13. Overlap ends and secure shall be offset to eliminate gaps.
14. Add 2-3 bags to cross barrier on downgradient side of silt fence or backfill to prevent failure of undercutting and or elevation based on site state of deterioration.

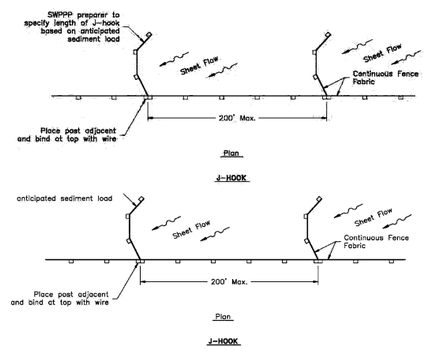
Detail is from SWPPP Appendix - BMP Guidance Fact Sheets and does not supersede any specifications elsewhere in the SWPPP or SWPPP

Silt Fence SE-1



Detail is from SWPPP Appendix - BMP Guidance Fact Sheets and does not supersede any specifications elsewhere in the SWPPP or SWPPP

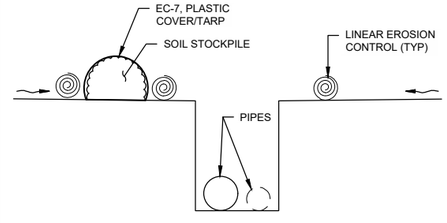
Silt Fence SE-1



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NOTES

1. STOCKPILE PLACEMENT TO BE DETERMINED BY CONTRACTOR IN FIELD. DIAGRAM FOR VISUAL PURPOSES ONLY. CONTRACTOR TO STORE EQUIPMENT IN SAME AREA AS STOCKPILE MATERIAL AND SHALL EMPLOY NS-8, 9 & 10 AS APPROPRIATE.
2. LINEAR EROSION CONTROLS ARE LIMITED DUE TO ENDANGERED SPECIES. CHECK WITH CONSTRUCTION REPRESENTATIVE FOR APPROVED MATERIALS.



1
13

TYPICAL TRENCH CROSS SECTION
NTS

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SEWER PIPELINE REPLACEMENT
CITY OF LOS BANOS
IN MERCED COUNTY
STORMWATER POLLUTION PREVENTION PLAN
DETAILS

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Appendix B: Construction Schedule

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Appendix C: Construction Activities, Materials Used, and Associated Pollutants

Table C POLLUTANTS ASSOCIATED WITH CONSTRUCTION ACTIVITIES

General Work Activity/ Products with Potential Stormwater Pollutants	Specific Work Activity/Products with Potential Stormwater Pollutants	Pollutant Categories
Adhesives	• Adhesives, glues, resins, epoxy synthetics, PVC cement • Caulks, sealers, putty, sealing agents and • Coal tars (naphtha, pitch)	Oil and Grease, Synthetic Organics[1]
Asphalt paving/curbs	• Hot and cold mix asphalt	Oil and Grease
Cleaners	• Polishes (metal, ceramic, tile) • Etching agents • Cleaners, ammonia, lye, caustic sodas, bleaching agents and chromate salts	Metals, Synthetic Organics
Concrete / Masonry	• Cement and brick dust • Colored chalks • Concrete curing compounds • Glazing compounds • Surfaces cleaners • Saw cut slurries • Tile cutting	Metals, Synthetic Organics
Framing/Carpentry	• Sawdust, particle board dust, and treated woods • Saw cut slurries	Metals, Synthetic Organics
Liquid waste	• Wash waters • Irrigation line testing/flushing	Metals, Synthetic Organics
Painting	• Paint thinners, acetone, methyl ethyl ketone, stripper paints, lacquers, varnish, enamels, turpentine, gum spirit, solvents, dyes, stripping pigments and sanding	Metals, Synthetic Organics
Planting / Vegetation Management	• Vegetation removal	Nutrients, Metals, Synthetic Organics
Plumbing	• Solder (lead, tin), flux (zinc chloride), pipe fitting • Galvanized metal in nails, fences, and electric wiring	Metals, Synthetic Organics
Removal of existing structures	• Demolition of asphalt, concrete, masonry, framing, roofing, metal structures.	Metals, Oil and Grease, Synthetic Organics
Sanitary waste	• Portable toilets • Disturbance of existing sewer lines.	Nutrients
Solid waste	• Litter, trash and debris • Vegetation	Gross Pollutants
Utility line testing and flushing	• Hydrostatic test water • Pipe flushing	Synthetic Organics

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Table C POLLUTANTS ASSOCIATED WITH CONSTRUCTION ACTIVITIES

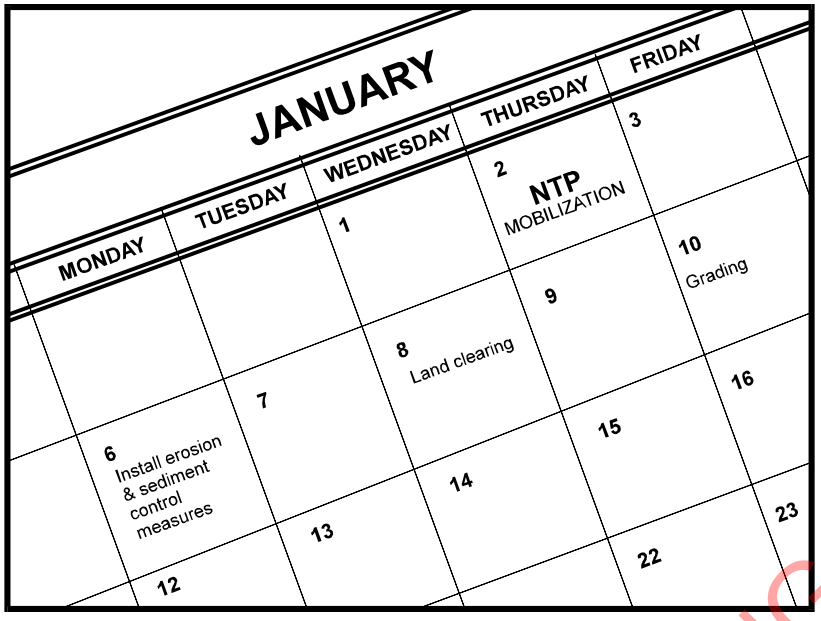
General Work Activity/ Products with Potential Stormwater Pollutants	Specific Work Activity/Products with Potential Stormwater Pollutants	Pollutant Categories
Vehicle and equipment use	• Equipment operation • Equipment maintenance • Equipment washing • Equipment fueling	Oil and Grease
Notes: 1. *Synthetic Organics are defined in Table 1.2 of the CASQA Stormwater BMP Handbook Portal: Construction as adhesives, cleaners, sealants, solvents, etc. These are generally categorized as VOCs or SVOCs.*		

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Appendix D: CASQA Stormwater BMP Handbook: Construction Fact Sheets

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Scheduling EC-1



Categories

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

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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.

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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.

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- Apply permanent erosion control to areas deemed substantially complete during the project's defined seeding window.
- Avoid soil disturbance during periods with high wind velocities.

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.

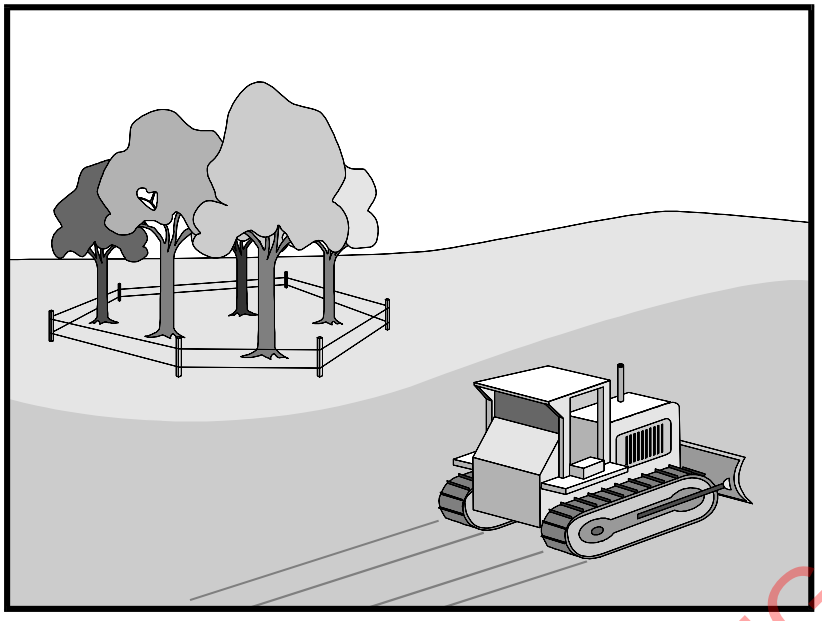
References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

Storm Water 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.

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Preservation of Existing Vegetation EC-2



Categories

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

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Description and Purpose

Carefully planned preservation of existing vegetation minimizes the potential of removing or injuring existing trees, vines, shrubs, and grasses that protect soil from erosion.

Suitable Applications

Preservation of existing vegetation is suitable for use on most projects. Large project sites often provide the greatest opportunity for use of this BMP. Suitable applications include the following:

- Areas within the site where no construction activity occurs or occurs at a later date. This BMP is especially suitable to multi year projects where grading can be phased.
- Areas where natural vegetation exists and is designated for preservation. Such areas often include steep slopes, watercourse, and building sites in wooded areas.
- Areas where local, state, and federal government require preservation, such as vernal pools, wetlands, marshes, certain oak trees, etc. These areas are usually designated on the plans, or in the specifications, permits, or environmental documents.
- Where vegetation designated for ultimate removal can be temporarily preserved and be utilized for erosion control and sediment control.
- Protecting existing vegetation buffers and swales.

Preservation of Existing Vegetation EC-2

Limitations

- Requires forward planning by the owner/developer, contractor, and design staff.
- Limited opportunities for use when project plans do not incorporate existing vegetation into the site design.
- For sites with diverse topography, it is often difficult and expensive to save existing trees while grading the site satisfactory for the planned development.

Implementation

The best way to prevent erosion is to not disturb the land. In order to reduce the impacts of new development and redevelopment, projects may be designed to avoid disturbing land in sensitive areas of the site (e.g., natural watercourses, steep slopes), and to incorporate unique or desirable existing vegetation into the site's landscaping plan. Clearly marking and leaving a buffer area around these unique areas during construction will help to preserve these areas as well as take advantage of natural erosion prevention and sediment trapping.

Existing vegetation to be preserved on the site must be protected from mechanical and other injury while the land is being developed. The purpose of protecting existing vegetation is to ensure the survival of desirable vegetation for shade, beautification, and erosion control. Mature vegetation has extensive root systems that help to hold soil in place, thus reducing erosion. In addition, vegetation helps keep soil from drying rapidly and becoming susceptible to erosion. To effectively save existing vegetation, no disturbances of any kind should be allowed within a defined area around the vegetation. For trees, no construction activity should occur within the drip line of the tree.

FOR BIDDING PURPOSES ONLY

Timing

- Provide for preservation of existing vegetation prior to the commencement of clearing and grubbing operations or other soil disturbing activities in areas where no construction activity is planned or will occur at a later date.

Design and Layout

- Mark areas to be preserved with temporary fencing. Include sufficient setback to protect roots.
  - Orange colored plastic mesh fencing works well.
  - Use appropriate fence posts and adequate post spacing and depth to completely support the fence in an upright position.
- Locate temporary roadways, stockpiles, and layout areas to avoid stands of trees, shrubs, and grass.
- Consider the impact of grade changes to existing vegetation and the root zone.
- Maintain existing irrigation systems where feasible. Temporary irrigation may be required.
- Instruct employees and subcontractors to honor protective devices. Prohibit heavy equipment, vehicular traffic, or storage of construction materials within the protected area.

- Consider pruning or mowing vegetation instead of removing it to allow for regrowth.
- If possible, retain vegetation buffer around the site and adjacent waterways.

Inspection and Maintenance

During construction, the limits of disturbance should remain clearly marked at all times. Irrigation or maintenance of existing vegetation should be described in the landscaping plan. If damage to protected trees still occurs, maintenance guidelines described below should be followed:

- Verify that protective measures remain in place. Restore damaged protection measures immediately.
- Serious tree injuries shall be attended to by an arborist.
- Damage to the crown, trunk, or root system of a retained tree shall be repaired immediately.
- Trench as far from tree trunks as possible, usually outside of the tree drip line or canopy. Curve trenches around trees to avoid large roots or root concentrations. If roots are encountered, consider tunneling under them. When trenching or tunneling near or under trees to be retained, place tunnels at least 18 in. below the ground surface, and not below the tree center to minimize impact on the roots.
- Do not leave tree roots exposed to air. Cover exposed roots with soil as soon as possible. If soil covering is not practical, protect exposed roots with wet burlap or peat moss until the tunnel or trench is ready for backfill.
- Cleanly remove the ends of damaged roots with a smooth cut.
- Fill trenches and tunnels as soon as possible. Careful filling and tamping will eliminate air spaces in the soil, which can damage roots.
- If bark damage occurs, cut back all loosened bark into the undamaged area, with the cut tapered at the top and bottom and drainage provided at the base of the wood. Limit cutting the undamaged area as much as possible.
- Aerate soil that has been compacted over a trees root zone by punching holes 12 in. deep with an iron bar and moving the bar back and forth until the soil is loosened. Place holes 18 in. apart throughout the area of compacted soil under the tree crown.
- Fertilization:
  - Fertilize trees in the late fall or early spring. Although to note, many native species do not require fertilization.
  - Apply fertilizer to the soil over the feeder roots and in accordance with label instructions, but never closer than 3 ft to the trunk. Increase the fertilized area by one-fourth of the crown area for conifers that have extended root systems.
- Retain protective measures until all other construction activity is complete to avoid damage during site cleanup and stabilization.

FOR BIDDING PURPOSES ONLY

References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

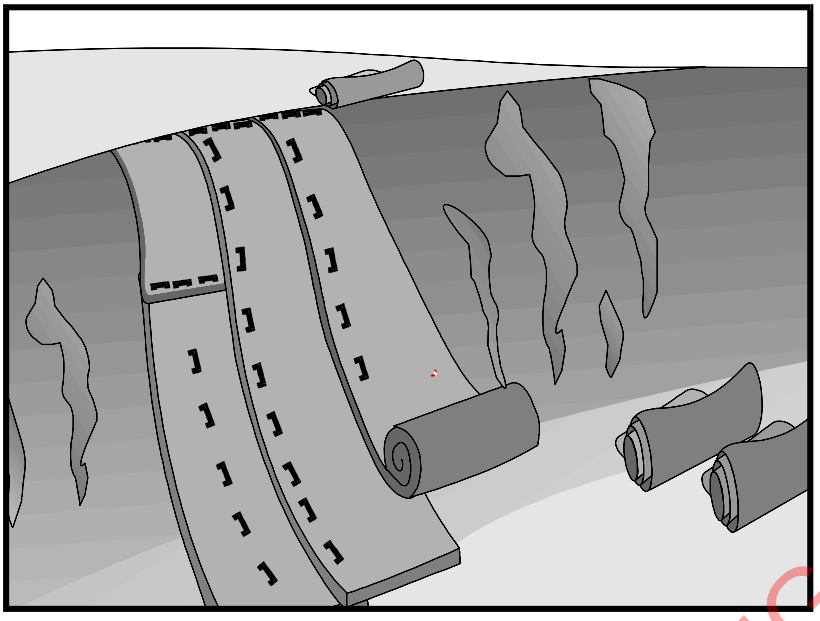
County of Sacramento Tree Preservation Ordinance, September 1981.

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Geotextiles and Mats EC-7



Categories

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 Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-4 Hydroseeding

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Description and Purpose

Rolled Erosion Control Products (RECPs), also known as erosion control matting or blankets, can be made of natural or synthetic materials or a combination of the two. RECPs 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, RECPs may be used to stabilize soils until vegetation is established or to reinforce non-woody surface vegetation.

Suitable Applications

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

- Steep slopes, generally steeper than 3:1 (H:V).
- Long slopes.
- Slopes where the erosion potential is high.
- Slopes and disturbed soils where mulch must be anchored.

- Disturbed areas where temporary cover is needed, or plants are slow to establish or will not establish.
- Channels with flows exceeding 3.3 ft/s.
- Channels to be vegetated.
- Stockpiles.
- Slopes adjacent to water bodies.

Limitations

- RECP installed costs are generally higher than other erosion control BMPs, limiting their use to areas where other BMPs are ineffective (e.g., channels, steep slopes).
- RECPs may delay seed germination, due to reduction in soil temperature and/or sunlight.
- RECPs 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). If a staple or pin cannot be driven into the soil because the underlying soil is too hard or rocky, then an alternative BMP should be selected.
- If used for temporary erosion control, RECPs should be removed and disposed of prior to application of permanent soil stabilization measures.
- The use of plastic sheeting should be limited to covering stockpiles or very small graded areas for short periods of time (such as through one imminent storm event) until other measures, such as seeding and mulching, may be installed.
  - Plastic sheeting is easily vandalized, easily torn, photodegradable, and must be disposed of at a landfill.
  - Plastic sheeting results in 100% runoff, which may cause serious erosion problems in the areas receiving the increased flow.
- According to the State Water Board's *CGP Review, Issue #2*, only RECPs that either do not contain plastic netting or contain netting manufactured from 100% biodegradable non-plastic materials, such as jute, sisal, or coir fiber should be used due to plastic pollution and wildlife concerns. If a plastic-netted product is used for temporary stabilization, it must be promptly removed when no longer needed and removed or replaced with non-plastic netted RECPs for final stabilization.
- RECPs may have limitations based on soil type, slope gradient, or channel flow rate; consult the manufacturer for proper selection.
- Not suitable for areas that have foot traffic (tripping hazard) – e.g., pad areas around buildings under construction.
- RECPs that incorporate a plastic netting (e.g. straw blanket typically uses a plastic netting to hold the straw in place) may not be suitable near known wildlife habitat. Wildlife can become trapped in the plastic netting. As per State Water Board guidance, RECPs that

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contain plastic netting are discouraged for temporary controls and are not acceptable alternatives for permanent controls. RECPs that do not contain plastic netting or contain netting manufactured from 100% biodegradable non-plastic materials such as jute, sisal, or coir fiber should be used.

- RECPs may have limitations in extremely windy climates; they are susceptible to wind damage and displacement. However, when RECPs are properly trenched at the top and bottom and stapled in accordance with the manufacturer's recommendations, problems with wind can be minimized.

Implementation

Material Selection

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

- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix B "Guidance on Selection of Temporary Slope Stabilization Techniques" of the CASQA Construction BMP Handbook.

- The following natural and synthetic RECPs are commonly used:

Geotextiles

- Material can be a woven or a non-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

- Generally plastic sheeting should only be used as stockpile covering or for very small graded areas for short periods of time (such as through one imminent storm event). If plastic sheeting must be used, choose a plastic that will withstand photo degradation.

- Plastic sheeting should have a minimum thickness of 6 mils and must be keyed in at the top of slope (when used as a temporary slope protection) 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 (when used as a temporary slope protection).

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- 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 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. See typical installation details at the end of this fact sheet.

  - **Jute** is a natural fiber that is made into a yarn that is loosely woven into a biodegradable mesh. The performance of jute as a stand-alone RECP is low. Most other RECPs outperform jute as a temporary erosion control product and therefore jute is not commonly used. It is designed to be used in conjunction with vegetation. 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

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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. Only biodegradable RECPs can remain on a site applying for a Notice of Termination due to plastic pollution and wild life concerns (State Waterboard, 2016). RECPs containing plastic that are used on a site must be disposed of for final stabilization.

  - **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.

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- **Bonded synthetic fibers** consist of a three-dimensional geometric 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 soil preparation is essential to ensure complete contact of the RECP with the soil. Soil Roughening is not recommended in areas where RECPs will be installed.
- 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.

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Seeding/Planting

Seed the area before blanket installation for erosion control and re-vegetation. Seeding after mat installation is often specified for turf reinforcement application. When seeding prior to blanket installation, all areas disturbed during blanket installation must be re-seeded. Where soil filling is specified for turf reinforcement mats (TRMs), 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. 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 shall be installed as required by the manufacturer.

Laying and Securing Matting

- Before laying the matting, all check slots should be installed and the seedbed should be friable, 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 (or greater, per manufacturer's specifications).
- 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. Check manufacturer's specifications to determine if a higher density staple pattern is required.

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.

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- 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 mat (TRM))

Installation should be in accordance with the manufacturer's recommendations. Typical installation guidelines are as follows:

- After seeding, spread and lightly rake ½-3/4 inches of fine topsoil into the TRM apertures to completely fill TRM thickness. Use backside of rake or other flat implement.
- Alternatively, if allowed by product specifications, spread topsoil using lightweight loader, backhoe, or other power equipment. Avoid sharp turns with equipment.
- 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.

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- 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.

Inspection and Maintenance

- RECPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- 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.

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References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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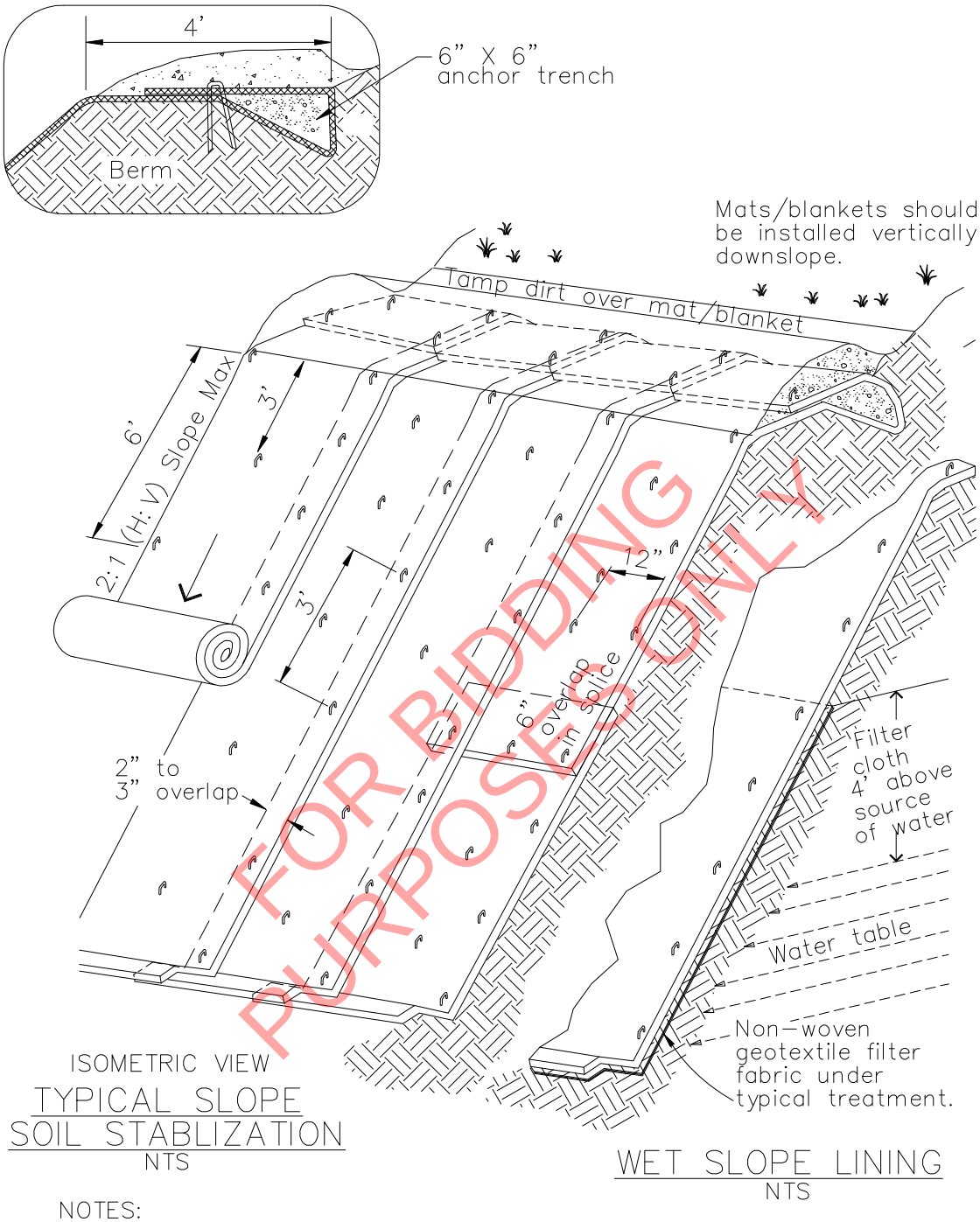
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ISOMETRIC VIEW

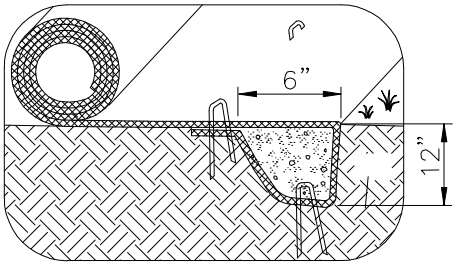
TYPICAL SLOPE
SOIL STABLIZATION
NTS

WET SLOPE LINING
NTS

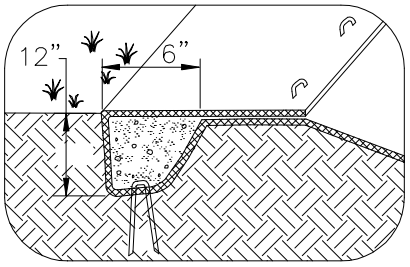
NOTES:

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

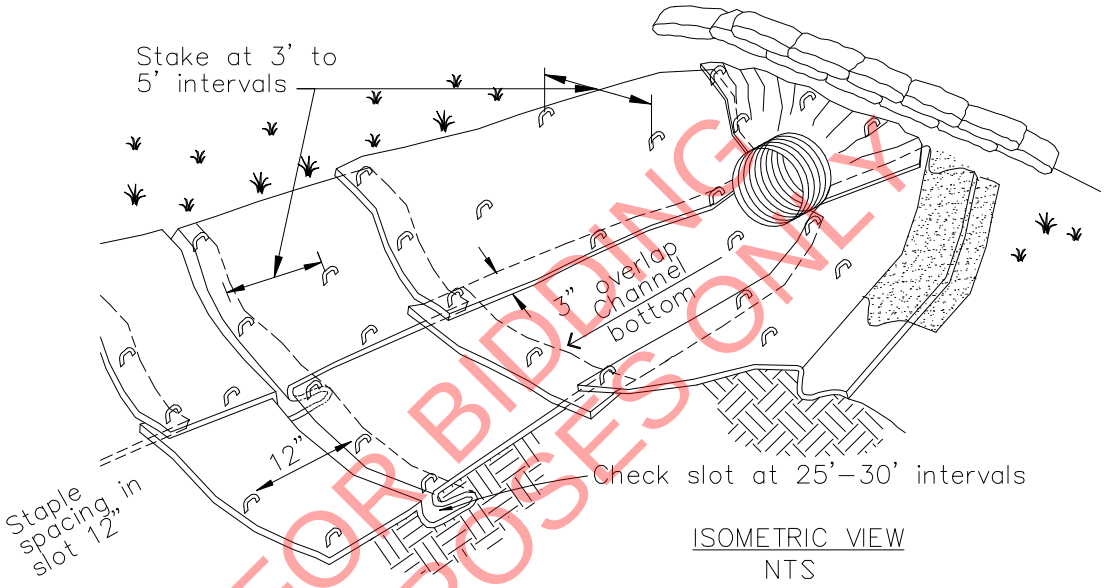
TYPICAL INSTALLATION DETAIL



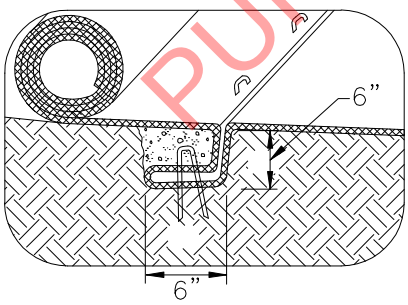
INITIAL CHANNEL ANCHOR TRENCH
NTS



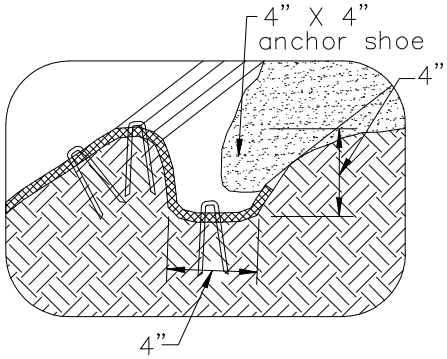
TERMINAL SLOPE AND CHANNEL ANCHOR TRENCH
NTS



ISOMETRIC VIEW
NTS



INTERMITTENT CHECK SLOT
NTS



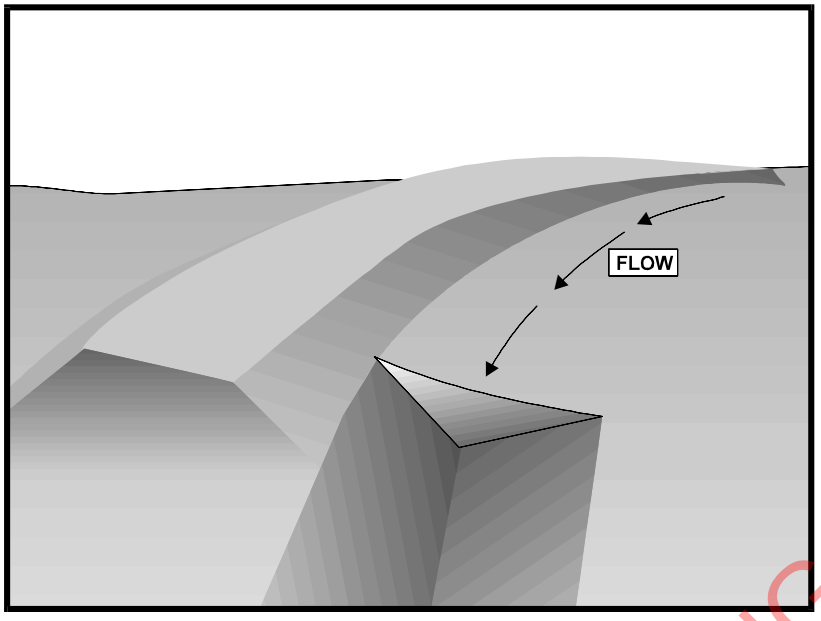
LONGITUDINAL ANCHOR TRENCH
NTS

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

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Earth Dikes and Drainage Swales EC-9



Categories

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

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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
  - To intercept and divert run-on
  - 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.
- Sediment accumulation, scour depressions, and/or persistent non-stormwater discharges can result in areas of standing water suitable for mosquito production in drainage swales.

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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.

FOR BIDDING PURPOSES ONLY

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.

- May be covered with hydro mulch, hydroseed, wood mulch, compost blanket, or RECP for stabilization.
- 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.

FOR BIDDING PURPOSES ONLY

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 %, but not more than 15 %.

- 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 % and use rip-rap or sod for swales with a slope between 5 and 15 %. 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.

FOR BIDDING PURPOSES ONLY

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 and Additional Resources

Construction Site Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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.

Metzger, M.E. 2004. Managing mosquitoes in stormwater treatment devices. University of California Division of Agriculture and Natural Resources, Publication 8125. On-line: http://anrcatalog.ucdavis.edu/pdf/8125.pdf

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

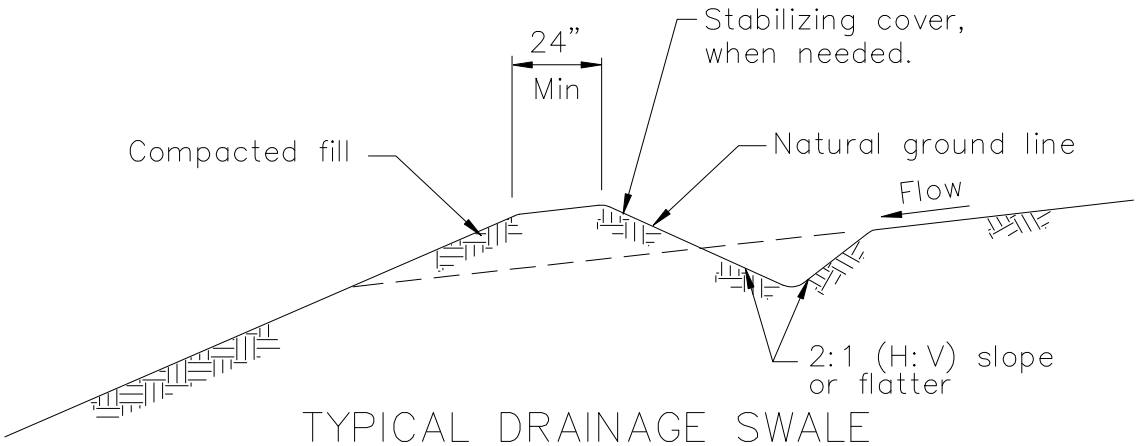
National Management Measures to Control Nonpoint Source Pollution from Urban Areas, United States Environmental Protection Agency, 2002.

Southeastern Wisconsin Regional Planning Commission (SWRPC). Costs of Urban Nonpoint Source Water Pollution Control Measures. Technical Report No. 31. Southeastern Wisconsin Regional Planning Commission, Waukesha, WI. 1991

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

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

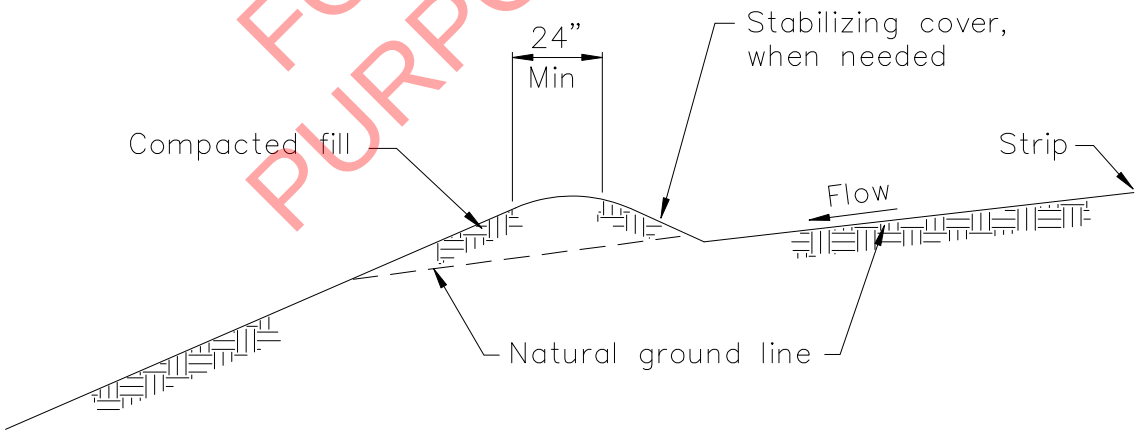
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TYPICAL DRAINAGE SWALE
NOT TO SCALE

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

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TYPICAL EARTH DIKE
NOT TO SCALE

Soil Preparation/Roughening EC-15



Categories

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 Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-3 Hydraulic Mulch

EC-5 Soil Binders

EC-7 Geotextiles and Mats

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Description and Purpose

Soil Preparation/Roughening involves assessment and preparation of surface soils for BMP installation. This can include soil testing (for seed base, soil characteristics, or nutrients), as well as roughening surface soils by mechanical methods (including sheepsfoot rolling, track walking, scarifying, stair stepping, and imprinting) to prepare soil for additional BMPs, or to break up sheet flow. Soil Preparation can also involve tilling topsoil to prepare a seed bed and/or incorporation of soil amendments, to enhance vegetative establishment.

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Suitable Applications

Soil preparation: Soil preparation is essential to proper vegetative establishment. In particular, soil preparation (i.e. tilling, raking, and amendment) is suitable for use in combination with any soil stabilization method, including Rolled Erosion Control Products (RECPs) or sod. Soil preparation should not be confused with roughening.

Roughening: Soil roughening is generally referred to as track walking (sometimes called imprinting) a slope, where treads from heavy equipment run parallel to the contours of the slope and act as mini terraces. Soil preparation is most effective when used in combination with erosion controls. Soil Roughening is suitable for use as a complementary process for controlling erosion on a site. Roughening is not intended to be used as a stand-alone BMP, and should be used with perimeter controls, additional erosion control measures, grade breaks, and vegetative establishment for maximum effectiveness. Roughening is intended to only affect surface soils and should not compromise slope stability or overall compaction. Suitable applications for soil roughening include:

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- Along any disturbed slopes, including temporary stockpiles, sediment basins, or compacted soil diversion berms and swales.

- Roughening should be used in combination with hydraulically applied stabilization methods, compost blanket, or straw mulch; but should not be used in combination with RECPs or sod because roughening is intended to leave terraces on the slope.

Limitations

- Preparation and roughening must take place prior to installing other erosion controls (such as hydraulically applied stabilizers) or sediment controls (such as fiber rolls) on the faces of slopes.

- In such cases where slope preparation is minimal, erosion control/revegetation BMPs that do not require extensive soil preparation - such as hydraulic mulching and seeding applications - should be employed.

- Consideration should be given to the type of erosion control BMP that follows surface preparation, as some BMPs are not designed to be installed over various types of tillage/roughening, i.e., RECPs should not be used with soil roughening due to a "bridging" effect, which suspends the blanket above the seed bed.

- Surface roughness has an effect on the amount of mulch material that needs to be applied, which shows up as a general increase in mulch material due to an increase in surface area (Topographic Index -see EC-3 Hydraulic Mulch).

Implementation

- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

General

A roughened surface can significantly reduce erosion. Based on tests done at the San Diego State Erosion Research Laboratory, various roughening techniques on slopes can result in a 12 - 76% reduction in the erosion rate versus smooth slopes.

Materials

Minimal materials are required unless amendments and/or seed are added to the soil. The majority of soil roughening/preparation can be done with equipment that is on hand at a normal construction site, such as bull dozers and compaction equipment.

Installation Guidelines

Soil Preparation

- Where appropriate or feasible, soil should be prepared to receive the seed by disking or otherwise scarifying the surface to eliminate crust, improve air and water infiltration and create a more favorable environment for germination and growth.

- Based upon soil testing conducted, apply additional soil amendments (e.g., fertilizers, additional seed) to the soil to help with germination. Follow EC-4, Hydroseeding, when selecting and applying seed and fertilizers.

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Cut Slope Roughening:

- Stair-step grade or groove the cut slopes that are steeper than 3:1.
- Use stair-step grading on any erodible material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.
- Make the vertical cut distance less than the horizontal distance, and slightly slope the horizontal position of the "step" in toward the vertical wall.
- Do not make individual vertical cuts more than 2 ft. (0.6 m) high in soft materials or more than 3 ft. (0.9 m) high in rocky materials.
- Groove the slope using machinery to create a series of ridges and depressions that run across the slope, on the contour.

Fill Slope Roughening:

- Place on fill slopes with a gradient steeper than 3:1 in lifts not to exceed 8 in. (0.2 m), and make sure each lift is properly compacted.
- Ensure that the face of the slope consists of loose, uncompacted fill 4-6 in. (0.1-0.2 m) deep.
- Use grooving or tracking to roughen the face of the slopes, if necessary.
- Do not blade or scrape the final slope face.

Roughening for Slopes to be Mowed:

- Slopes that require mowing activities should not be steeper than 3:1.
- Roughen these areas to shallow grooves by track walking, scarifying, sheepsfoot rolling, or imprinting.
- Make grooves close together (less than 10 in.), and not less than 1 in. deep, and perpendicular to the direction of runoff (i.e., parallel to the slope contours).
- Excessive roughness is undesirable where mowing is planned.

Roughening with Tracked Machinery:

- Limit roughening with tracked machinery to soils with a sandy textural component to avoid undue compaction of the soil surface.
- Operate tracked machinery up and down the slope to leave horizontal depressions in the soil. Do not back-blade during the final grading operation.
- Seed and mulch roughened areas as soon as possible to obtain optimum seed germination and growth.

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Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Check the seeded slopes for signs of erosion such as rills and gullies. Fill these areas slightly above the original grade, then reseed and mulch as soon as possible.
- Inspect BMPs weekly during normal operations, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

References and Additional Resources

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Soil Stabilization BMP Research for Erosion and Sediment Controls: Cost Survey Technical Memorandum, State of California Department of Transportation (Caltrans), July 2007.

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Non-Vegetative Stabilization EC-16



Categories

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 Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

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Description and Purpose

Non-vegetative stabilization methods are used for temporary or permanent stabilization of areas prone to erosion and should be used only where vegetative options are not feasible; examples include:

- Areas of vehicular or pedestrian traffic such as roads or paths;
- Arid environments where vegetation would not provide timely ground coverage, or would require excessive irrigation;
- Rocky substrate, infertile or droughty soils where vegetation would be difficult to establish; and
- Areas where vegetation will not grow adequately within the construction time frame.

There are several non-vegetative stabilization methods and selection should be based on site-specific conditions.

Decomposed Granite (DG) is a permanent erosion protection method that consists of a layer of stabilized decomposed granite placed over an erodible surface.

Degradable Mulches of various types (see EC-3, EC-6, EC-8) can be used for temporary non-vegetative stabilization; examples include straw mulch, compost, wood chips or hydraulic mulch.

Geotextiles and Mats can be used for temporary non-vegetative stabilization (see EC-7). These BMPs are typically manufactured from degradable or synthetic materials and are

designed and specified based on their functional longevity, i.e., how long they will persist and provide erosion protection. All geotextiles and mats should be replaced when they exceed their functional longevity or when permanent stabilization methods are instituted.

Gravel Mulch is a non-degradable erosion control product that is composed of washed and screened coarse to very coarse gravel, 16 mm to 64 mm (0.6" - 2.5"), similar to an AASHTO No. 3 coarse aggregate.

Rock Slope Protection consists of utilizing large rock or rip-rap (4"- 24") to stabilize slopes with a high erosion potential and those subject to scour along waterways.

Soil Binders can be used for temporary non-vegetative stabilization (see EC-5). The key to their use is functional longevity. In most cases, the soil binder will need to be routinely monitored and re-applied to maintain an erosion-resistant coverage.

Suitable Applications

Non-vegetated stabilization methods are suitable for use on disturbed soil areas and on material stockpiles that need to be temporarily or permanently protected from erosion by water and wind. Non-vegetated stabilization should only be utilized when vegetation cannot be established in the required timeframe, due to soil or climactic conditions, or where vegetation may be a potential fire hazard.

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Decomposed Granite (DG) and Gravel Mulch are suitable for use in areas where vegetation establishment is difficult, on flat surfaces, trails and pathways, and when used in conjunction with a stabilizer or tackifier, on shallow slopes (i.e., 10:1 [H:V]). DG and gravel can also be used on shallow rocky slopes where vegetation cannot be established for permanent erosion control.

Degradable Mulches can be used to cover and protect soil surfaces from erosion both in temporary and permanent applications. In many cases, the use of mulches by themselves requires routine inspection and re-application. See EC-3 Hydraulic Mulch, EC-6 Straw Mulch, EC-8 Wood Mulch, or EC-14 Compost Blankets for more information.

Geotextiles and Mats can be used as a temporary stand-alone soil stabilization method. Depending on material selection, geotextiles and mats can be a short-term (3 mos – 1 year) or long-term (1-2 years) temporary stabilization method. For more information on geotextiles and mats see EC-7 Geotextiles and Mats.

Rock Slope Protection can be used when the slopes are subject to scour or have a high erosion potential, such as slopes adjacent to flowing waterways or slopes subject to overflow from detention facilities (spillways).

Soil Binders can be used for temporary stabilization of stockpiles and disturbed areas not subject to heavy traffic. See EC-5 Soil Binders for more information.

Limitations

General

- Refer to EC-3, EC-6, EC-8, and EC-14 for limitations on use of mulches. Refer to EC-7 for limitations on use of geotextiles and mats. Refer to EC-5 for limitations on use of Soil Binders.

Decomposed Granite

- Not available in some geographic regions.
- If not tackified, material may be susceptible to erosion even on slight slopes (e.g., 30:1 [H:V]).
- Installed costs may be more expensive than vegetative stabilization methods.

Gravel Mulch

- Availability is limited in some geographic regions.
- If not properly screened and washed, can contain fine material that can erode and/or create dust problems.
- If inadequately sized, material may be susceptible to erosion on sloped areas.
- Pore spaces fill with dirt and debris over time; may provide a growing medium for weeds.

Rock Slope Protection

- Installation is labor intensive.
- Installed costs can be significantly higher than vegetative stabilization methods.
- Rounded stones may not be used on slopes greater than 2:1 [H:V].

Implementation

General

Non-vegetated stabilization should be used in accordance with the following general guidance:

- Should be used in conjunction with other BMPs, including drainage, erosion controls and sediment controls.
- Refer to EC-3, EC-6, EC-8, and EC-14 for implementation details for mulches. Refer to EC-7 for implementation details for geotextiles and mats. Refer to EC-5 for implementation details for soil binders.
- Non-vegetated stabilization measures should be implemented as soon as the disturbance in the areas they are intended to protect has ceased.
- Additional guidance on the comparison and selection of temporary slope stabilization methods is provided in Appendix F of the Handbook.

Decomposed Granite Stabilization

- If used for a road or path should be installed on a prepared base.
- Should be mixed with a stabilizer if used for roads or pathways, or on slope applications.
- Though porous it is recommended to prevent standing water on or next to a decomposed granite road or pathway.

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Gravel Mulch

- Should be sized based on slope, rainfall, and upgradient run-on conditions. Stone size should be increased as potential for erosion increases (steeper slopes, high intensity rainfall).
- If permanent, a weed control fabric should be placed prior to installation.
- Should be installed at a minimum 2" depth.
- Should completely cover all exposed surfaces.

Rock Slope Protection

- Rock slope protection installation should follow Caltrans Standard Specification 72-2: Rock Slope Protection. Refer to the specification for rock conformity requirements and installation methods.
- When using rock slope protection, rock size and installation method should be specified by an Engineer.
- A geotextile fabric should be placed prior to installation.

Inspection and Maintenance

General

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- For permanent installation, require inspection periodically and after major storm events to look for signs of erosion or damage to the stabilization.
- All damage should be repaired immediately.
- Refer to EC-3, EC-6, EC-8, and EC-14 for inspection and maintenance requirements for mulches. Refer to EC-7 for inspection and maintenance requirements for geotextiles and mats. Refer to EC-5 for inspection and maintenance requirements for soil binders.

Decomposed Granite and Gravel Mulch Stabilization

- Rake out and add decomposed granite or gravel as needed to areas subject to rill erosion. Inspect upgradient drainage controls and repair/modify as necessary.
- Should remain stable under loose surface material. Any significant problem areas should be repaired to restore uniformity to the installation.

References and Additional Resources

Arid Zone Forestry: A Guide for Field Technicians. Food and Agriculture Organization of the United Nations, 1989.

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Construction Site Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

Design of Roadside Channels with Flexible Linings, Hydraulic Engineering Circular Number 15, Third Edition, Federal Highway Administration, 2007.

Design Standards for Urban Infrastructure - Soft Landscape Design, Department of Territory and Municipal Services - Australian Capital Territory http://www.tams.act.gov.au/work/standards_and_procedures/design_standards_for_urban_infrastructure

Erosion and Sediment Control Handbook: A Guide for Protection of State Waters through the use of Best Management Practices during Land Disturbing Activities, Tennessee Department of Environment and Conservation, 2002.

Gravel Mulch, Landscape Architecture Non-Standard Specification 10-2, California Department of Transportation (Caltrans), http://www.dot.ca.gov/hq/LandArch/roadside/detail-gm.htm

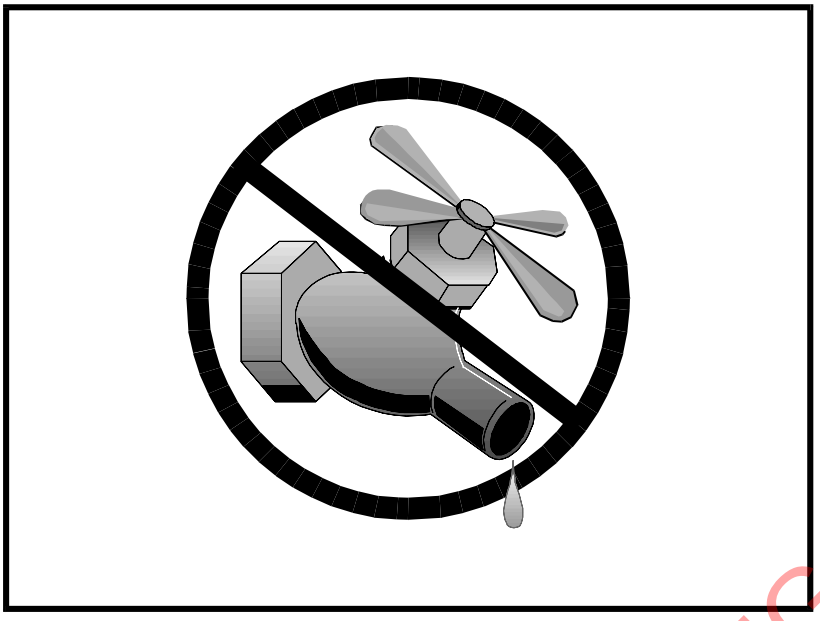
Maine Erosion and Sediment Control BMPs, DEPLW0588, Maine Department of Environmental Protection: Bureau of Land and Water Quality, 2003.

National Menu of Best Management Practices, US Environmental Protection Agency, 2006.

Standard Specification 72-2: Rock Slope Protection. California Department of Transportation, 2006.

FOR BIDDING PURPOSES ONLY

Water Conservation Practices NS-1



Categories

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

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Description and Purpose

Water conservation practices are activities that use water during the construction of a project in a manner that avoids causing erosion and the transport of pollutants offsite. These practices can reduce or eliminate non-stormwater discharges.

Suitable Applications

Water conservation practices are suitable for all construction sites where water is used, including piped water, metered water, trucked water, and water from a reservoir.

Limitations

- None identified.

Implementation

- Keep water equipment in good working condition.
- Stabilize water truck filling area.
- Repair water leaks promptly.
- Washing of vehicles and equipment on the construction site is discouraged.
- Avoid using water to clean construction areas. If water must be used for cleaning or surface preparation, surface should be swept and vacuumed first to remove dirt. This will minimize amount of water required.

- Direct construction water runoff to areas where it can soak into the ground or be collected and used.
- Authorized non-stormwater discharges to the storm drain system, channels, or receiving waters are acceptable with the implementation of appropriate BMPs.
- Lock water tank valves to prevent unauthorized use.

Inspection and Maintenance

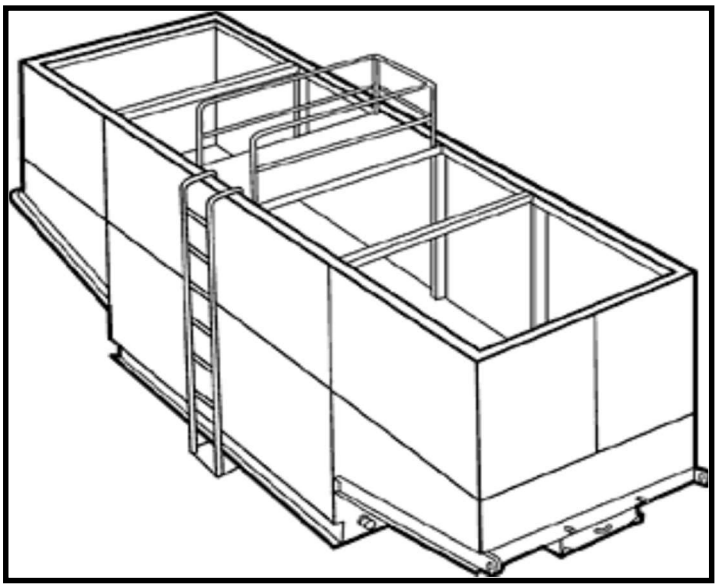
- Inspect and verify that activity based BMPs are in place prior to the commencement of authorized non-stormwater discharges.
- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges are occuring.
- Repair water equipment as needed to prevent unintended discharges.
  - Water trucks
  - Water reservoirs (water buffalos)
  - Irrigation systems
  - Hydrant connections

References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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Dewatering Operations NS-2



Categories

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 Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

SE-5: Fiber Roll

SE-13: Compost Sock/Berm

SE-6: Gravel Bag Berm

NS-5: Clear Water Diversion

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Description and Purpose

Dewatering operations are practices that manage the discharge of pollutants when non-stormwater, non-potable water, and accumulated precipitation (stormwater) is removed from a work location to proceed with construction work or to provide vector control.

The 2022 General Permit defines dewatering as the process of removing excess water in an excavation or impoundment by pumping or other mechanical means. Dewatering discharges authorized by the 2022 General Permit include mechanical pumping or syphoning of non-potable water from sources including, but not limited to: excavations, trenches, foundations, vaults, groundwater removal specifically related to the construction activities, and/or water collected in impoundments (e.g., ponds, puddles, low points on the active site, or other similar accumulation points).

This factsheet specifically incorporates the 2022 General Permit, Attachment J requirements. Dewatering activities subject to a separate National Pollutant Discharge Elimination System (NPDES) permit (e.g., de minimis and low threat discharges) are not subject to the dewatering requirements of Attachment J; obtain separate coverage as required by the State Water Resources Control Board (SWRCB) or the applicable Regional Water Quality Control Board (RWQCB). Potentially applicable NPDES Permits for Dewatering Discharges are listed in the SWRCB's Dewatering Discharge Notification Guidance (SWRCB, 2024). Ensure that dewatering activities not subject to a separate NPDES permit comply with the dewatering requirements in Attachment J (Section IV.M. of the 2022 General Permit).

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The General Permit incorporates Numeric Action Levels (NALs) for pH and turbidity for dewatering discharges. Discharges from dewatering operations can contain high levels of fine sediment that, if not properly treated, could lead to exceedances of the General Permit requirements or Basin Plan standards.

The dewatering operations described in this fact sheet are not Active Treatment Systems (ATS) SE-11) and do not include the use of chemical coagulants, chemical flocculants or electrocoagulants. ATS that are not subject to a separate NPDES permit must comply with the ATS requirements in Attachment F of the 2022 General Permit.

Discharges from Sediment Basins (SE-2) and Sediment Traps (SE-3) may be subject to the dewatering requirements of Attachment J of the 2022 General Permit. Sediment basin and sediment trap configuration and valve design, required drawdown time for vector control, operational drawdown in case of more frequent storms or storms larger than the design storm, or other unforeseen site conditions may result in the need to dewater a sediment basin and/or sediment trap, thus triggering Attachment J. Sediment basins and sediment traps that discharge under gravity flow with no mechanical pumping or syphoning, for example containing a skimmer or standpipe outlet structure, are not considered dewatering practices that would trigger the requirements of Attachment J.

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Suitable Applications

Dewatering practices are implemented for discharges of non-stormwater, non-potable water, and accumulated stormwater by mechanical pumping or syphoning from construction sites.

Non-stormwaters include, but are not limited to, groundwater, water from cofferdams, water diversions, and waters used during construction activities that must be removed from a work area to facilitate construction.

Practices identified in this section are also appropriate for implementation when managing the removal of accumulated precipitation (stormwater) from depressed areas at a construction site.

Stormwater mixed with non-stormwater or non-potable water should be managed as non-stormwater.

A clear water diversion is typically implemented where appropriate permits (401 Certification, 1602 Agreement, etc.) have been secured and work must be performed in a flowing stream or water body. If dewatering associated with a clear water diversion is required for your project, refer to Clear Water Diversion (NS-5).

Limitations

- Dewatering operations need to comply with applicable local and project-specific permits and regulations. In some areas, all dewatering activities require a dewatering permit.
- The discharge must be absent of pollutants in quantities that threaten to cause pollution or a nuisance.[1]
- The dewatering activity may only take place in an area without known soil and/or groundwater contamination (including, but not limited to information from: GeoTracker,[2]

[1] 40 Code of Federal Regulations section 131.12, and SWRCB Resolution No. 68-16.
[2] https://geotracker.waterboards.ca.gov/

local permitting authorities, RWQCBs, etc.) where that contamination could cause an exceedance of receiving water limitations.

- The dewatering activity must be in compliance with the receiving water limitations listed in General Permit, Section IV.D, including applicable TMDLs listed in Attachment H.
- Utilize outlet structures that withdraw water from the surface when conducting dewatering activity from sediment basins or similar impoundments, unless infeasible.
- Site conditions will dictate the design and use of dewatering operations.
- The controls discussed in this fact sheet primarily address sediment. Other secondary pollutant removal benefits are discussed where applicable.

Implementation

- Avoid dewatering discharges where possible by using the water, with appropriate approvals or permits, for onsite dust control, pumping to an onsite area for infiltration, disposing off, or site discharging to the sanitary sewer.
- Include dewatering monitoring in the Construction Site Monitoring Plan (CSMP) in the project Stormwater Pollution Prevention Plan (SWPPP).
- At least 24 hours prior to beginning a dewatering discharge notify the applicable RWQCB stormwater staff via email of the anticipated dewatering discharge. The general stormwater staff email addresses for each RWQCB may be found in Attachment C of the 2022 CGP or at the SWRCB website (https://www.waterboards.ca.gov/water_issues/programs/stormwater/contact.html).
- A separate notification is required if there are changes to the dewatering activities (SWRCB, 2024).
- Analyze the dewatering effluent for pH and turbidity at the discharge location within the first hour of discharge and daily for continuous dewatering discharges. Each sample must instantaneously comply with the NALs for pH (within 6.5-8.5 standard pH units) and turbidity (250 nephelometric turbidity units).
- Cease discharge when the NALs are exceeded in a single sample, as follows:
  - Through an automated sampling device capable of ceasing the discharge if a single sample concentration/level exceeds the NALs;
  - By a Qualified SWPPP Practitioner (QSP) or trained QSP-delegate who is present during the dewatering activity and can halt dewatering if a NAL is exceeded for a single sample;

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  - If discharge cannot be ceased due to the need to protect human life or health or to prevent severe property damage, notify the RWQCB and local stormwater agency within 24 hours; or
  - If discharge that exceeds pH and turbidity NALs cannot be stopped, notify the RWQCB and local stormwater agency within 24 hours.

- Following the NAL exceedance the Qualified SWPPP Developer (QSD) will revise the SWPPP to incorporate corrective actions to prevent further exceedances, within 10 days of the exceedance.
- The SWRCB and RWQCB, upon written notice, may:
  - Require additional constituents to be monitored;
  - Require additional or more frequent monitoring;
  - Require additional or different sampling locations;
  - Require treatment of the discharge with ATS (in accordance with Attachment F of the General Permit; and/or
  - Revoke authorization of dewatering discharges under the General Permit and require separate NPDES permit coverage for dewatering discharges to Waters of the U.S.
- The destination of discharge from dewatering activities will typically determine the type of permit required for the discharge. For example, when discharging to a water of the U.S., a dewatering permit may be required through the site's governing RWQCB. When discharging to a sanitary sewer a permit may need to be obtained from the owner of the sanitary sewer. When discharging to a Municipal Separate Storm Sewer System (MS4) a permit from the MS4 may be needed in addition to obtaining an RWQCB dewatering permit. Additional permits or permissions from other agencies may be required for dewatering cofferdams or diversions.
- Dewatering discharges may not cause erosion at the discharge point. Potential BMPs to limit erosion include:
  - Directly piping discharge to a storm drain inlet or hardened channel,
  - Geotextiles and Mats (EC-7),
  - Velocity Dissipation Devices (EC-10), Slope Drains (EC-11), and
  - Check Dams (SE-4).
- Appropriate BMPs must be implemented to maintain compliance with all applicable permits.
- Per the requirements of Attachment J, the QSD must update the site-specific SWPPP onsite at least 24 hours prior to the beginning of a dewatering discharge and upload the amended

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SWPPP to SMARTS within 14 days with current information required. The revised SWPPP must be uploaded as part of a Change of Information through SMARTS.

- Maintain dewatering records in accordance with all local and project-specific permits and regulations.

Inspection and Maintenance

- Inspect and verify that dewatering BMPs are in place and functioning prior to the commencement of activities requiring dewatering.
- Inspect dewatering BMPs daily while dewatering activities are being conducted.
- Inspect all equipment before use. Monitor dewatering operations to ensure they do not cause offsite discharge or erosion.
- Sample and monitor dewatering discharges as required by the General Permit.
- Unit-specific maintenance requirements are included with the description of each unit.
- Sediment removed during the maintenance of a dewatering device may be either spread onsite and stabilized or disposed of at a disposal site as approved by the owner and documented in the SWPPP.
- Sediment that is commingled with other pollutants will be disposed of in accordance with all applicable laws and regulations and as approved by the owner.

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Sediment Removal

A variety of methods can be used to treat water during dewatering operations. Several devices are presented below and provide options to achieve sediment removal. The sediment particle size and permit or receiving water limitations on sediment or turbidity are key considerations for selecting sediment treatment option(s); in some cases, the use of multiple devices may be appropriate. Use of other enhanced treatment methods (i.e., introduction of chemicals or electric current to enhance flocculation and removal of sediment) must comply with: 1) for storm drain or surface water discharges, the requirements for ATS (see SE-11 and Attachment F of the General Permit); 2) for storm drain or surface water discharges, the requirements for Passive Treatment (see SE-15 and Attachment G of the General Permit); or 3) for sanitary sewer discharges, the requirements of applicable sanitary sewer discharge permits.

Sediment Basin (see also SE-2)

Description:

- A sediment basin is a temporary basin with a controlled release structure that is formed by excavation or construction of an embankment to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment basins are larger than Sediment Traps (SE-3) and have a designed outlet structure.

Appropriate Applications:

- Effective for the removal of trash, gravel, sand, silt, some metals that settle out with the sediment.

Implementation:

- Excavation and construction of related facilities is required.
- Temporary sediment basins should be fenced if safety is a concern.
- Outlet protection is required to prevent erosion at the outfall location.
- Discharges from sediment basins containing a skimmer or standpipe outlet structure that occur as a result of gravity flow with no mechanical pumping or syphoning, are not considered dewatering practices that would trigger the requirements of Attachment J.
- Discharges from sediment basins containing a skimmer or standpipe outlet structure that occur as a result of mechanical pumping or syphoning are considered dewatering practices that would trigger the requirements of Attachment J.

Maintenance:

- Maintenance is required for safety fencing, vegetation, embankment, inlet and outlet structures, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-third.

Sediment Trap (See also SE-3)

Description:

- A sediment trap is a temporary basin formed by excavation and/or construction of an earthen embankment across a waterway or low drainage area to detain sediment-laden runoff and allow sediment to settle out before discharging. Sediment traps are smaller than Sediment Basins (SE-2) and do not have a designed outlet (but do have a spillway or overflow).

Appropriate Applications:

- Effective for the removal of large and medium sized particles (sand and gravel) and some metals that settle out with the sediment.

Implementation:

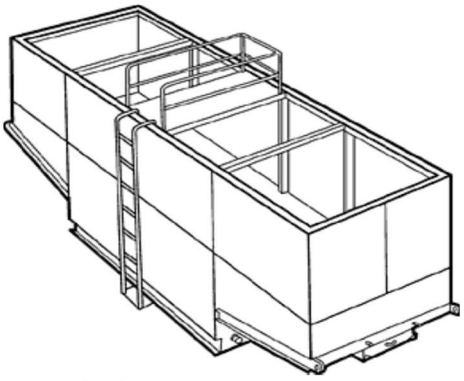
- Excavation and construction of related facilities is required.
- Trap inlets should be located to maximize the travel distance to the trap outlet.
- Use rock or vegetation to protect the trap outlets against erosion.
- Discharges from sediment traps containing a skimmer or standpipe outlet structure that occur as a result of gravity flow with no mechanical pumping or syphoning are not considered dewatering practices that would trigger the requirements of Attachment J.
- Discharges from sediment traps containing a skimmer or standpipe outlet structure that occur as a result of mechanical pumping or syphoning are considered dewatering practices that would trigger the requirements of Attachment J.

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Maintenance:

- Maintenance is required for vegetation, embankment, inlet and outfall structures, as well as other features.
- Removal of sediment is required when the storage volume is reduced by one-third.

Weir Tanks



Description:

- A weir tank separates water and waste by using weirs. The configuration of the weirs (over and under weirs) maximizes the residence time in the tank and determines the waste to be removed from the water, such as oil, grease, and sediments.

Appropriate Applications:

- The tank removes trash, some settleable solids (gravel, sand, and silt), some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

Implementation:

- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.
- Treatment capacity (i.e., volume and number of tanks) should provide at a minimum the required volume for discrete particle settling for treatment design flows.
- Discharges from weir tanks that occur as a result of gravity flow with no mechanical pumping or syphoning are not considered dewatering practices that would trigger the requirements of Attachment J.
- Discharges from weir tanks that occur as a result of mechanical pumping or syphoning are considered dewatering practices that would trigger the requirements of Attachment J.

Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.

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- Use a licensed waste disposal company to dispose of oil and grease.

Dewatering Tanks



Description:

- A dewatering tank removes debris and sediment. Flow enters the tank through the top, passes through a fabric filter, and is discharged through the bottom of the tank. The filter separates the solids from the liquids.

Appropriate Applications:

- The tank removes trash, gravel, sand, and silt, some visible oil and grease, and some metals (removed with sediment). To achieve high levels of flow, multiple tanks can be used in parallel. If additional treatment is desired, the tanks can be placed in series or as pre-treatment for other methods.

Implementation:

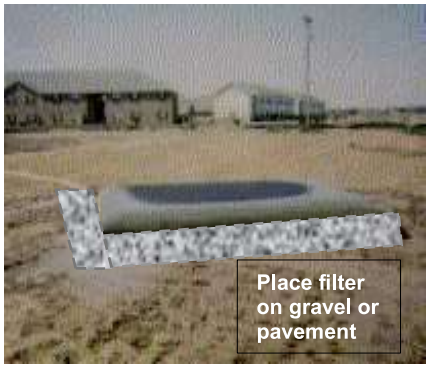
- Tanks are delivered to the site by the vendor, who can provide assistance with set-up and operation.
- Tank size will depend on flow volume, constituents of concern, and residency period required. Vendors should be consulted to appropriately size tank.
- Discharges from dewatering tanks through mechanical pumping or syphoning are considered dewatering practices that would trigger the requirements of Attachment J.

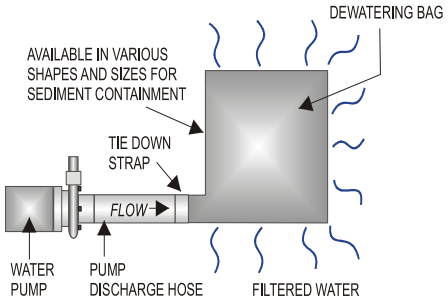
Maintenance:

- Periodic cleaning is required based on visual inspection or reduced flow.
- Use a licensed waste disposal company to dispose of oil and grease.

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Gravity Bag Filter





Description:

- A gravity bag filter, also referred to as a dewatering bag, is a square or rectangular bag made of non-woven geotextile fabric that collects gravel, sand, silt, and fines.

Appropriate Applications:

- Effective for the removal of sediments (gravel, sand, and silt). Gravity bag filters may be ineffective for the removal of fines and clays, especially in the initial stages of discharge.
- Some metals are removed with the sediment.

Implementation:

- Water is pumped into one side of the bag and seeps through the top, bottom, and sides of the bag.
- Place the filter bag on pavement or a gravel bed or paved surface. Avoid placing a dewatering bag on unprotected bare soil. If placing the bag on bare soil is unavoidable, a secondary barrier should be used, such as a rock filter bed placed beneath and beyond the edges of the bag to prevent erosion and capture sediments that escape the bag.
- Implement perimeter controls around the downstream end of the bag. Secondary sediment controls are important especially in the initial stages of discharge, which tend to allow fines to pass through the bag.
- Discharges from filter bags through gravity flow are not considered dewatering practices that would trigger the requirements of Attachment J.

Maintenance:

- Inspections of the flow conditions, bag condition, bag capacity, and the secondary barrier (as applicable) are required as per the manufacturer's recommendation.
- Replace the bag when it no longer filters sediment or passes water at a reasonable rate.
- Caution should be taken when removing and disposing of the bag, to prevent the release of captured sediment.

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- Properly dispose of the bag offsite. If sediment is removed from the bag prior to disposal (bags can potentially be reused depending upon their condition), dispose of sediment in accordance with the general maintenance procedures described in this BMP Fact Sheet.

Sand Media Particulate Filter





Description:

- Water is treated by passing it through canisters filled with sand media. Generally, sand filters provide a final level of treatment. They are often used as a secondary or higher level of treatment after a significant amount of sediment and other pollutants have been removed using other methods.

Appropriate Applications:

- Effective for the removal of trash, gravel, sand, and silt, and some metals, as well as the reduction of biochemical oxygen demand (BOD) and turbidity.
- Sand filters can be used for stand-alone treatment or in conjunction with bag and cartridge filtration if further treatment is required.
- Sand filters can also be used to provide additional treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.
- Discharges from sand filters through mechanical pumping or syphoning are considered dewatering practices that would trigger the requirements of Attachment J.

Maintenance:

- The filters require regular service to monitor and maintain the level of the sand media. If subjected to high loading rates, filters can plug quickly.
- Vendors generally provide data on maximum head loss through the filter. Monitor the filter daily while in use and cleaned when head loss reaches target levels.

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- If cleaned by backwashing, the backwash water may need to be hauled away for disposal or returned to the upper end of the treatment train for another pass through the series of dewatering BMPs.

Pressurized Bag Filter





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Description:

- A pressurized bag filter is a unit composed of single filter bags made from polyester felt material. The water filters through the unit and is discharged through a header. Vendors provide bag filters in a variety of configurations. Some units include a combination of bag filters and cartridge filters for enhanced contaminant removal.

Appropriate Applications:

- Effective for the removal of sediment (sand and silt) and some metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Oil absorbent bags are available for hydrocarbon removal.
- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance with installation and operation.
- Discharges from pressurized bag filter through mechanical pumping or syphoning are considered dewatering practices that would trigger the requirements of Attachment J.

Maintenance:

- The filter bags require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

Cartridge Filter



Description:

- Cartridge filters provide a high degree of pollutant removal by utilizing a number of individual cartridges as part of a larger filtering unit. They are often used as a secondary or higher (polishing) level of treatment after a significant amount of sediment and other pollutants are removed. Units come with various cartridge configurations (for use in series with bag filters) or with a larger single cartridge filtration unit (with multiple filters within).

Appropriate Applications:

- Effective for the removal of sediment (sand, silt, and some clays) and metals, as well as the reduction of BOD, turbidity, and hydrocarbons. Hydrocarbons can effectively be removed with special resin cartridges.
- Filters can be used to provide secondary treatment to water treated via settling or basic filtration.

Implementation:

- The filters require delivery to the site and initial set up. The vendor can provide assistance.
- Discharges from cartridge filters through mechanical pumping or syphoning are considered dewatering practices that would trigger the requirements of Attachment J.

Maintenance:

- The cartridges require replacement when the pressure differential equals or exceeds the manufacturer's recommendation.

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References and Additional Resources

California Department of Transportation (Caltrans). 2024. Construction Site Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1.

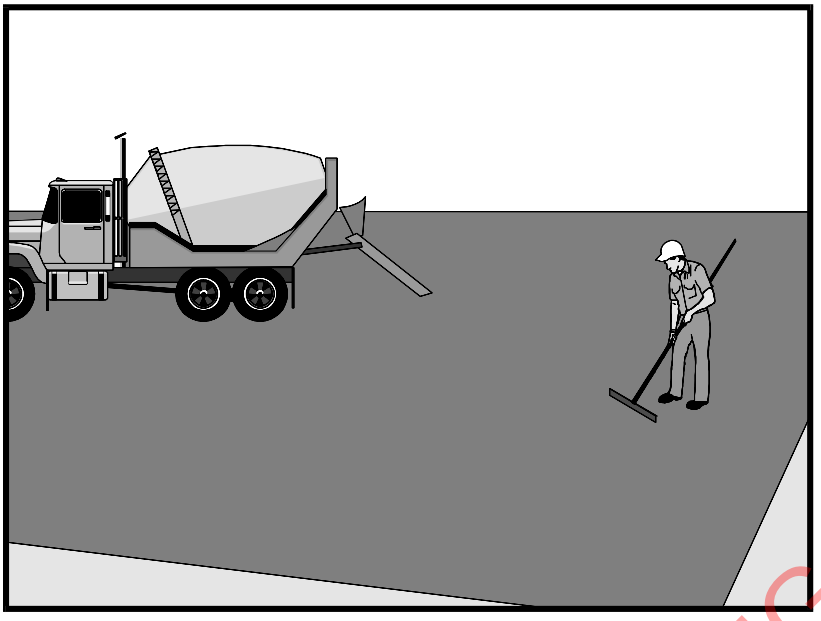
California State Water Resources Control Board (SWRCB). 2022. Order 2022-0057-DWQ, NPDES General Permit No. CAS000002: National Pollutant Discharge Elimination System (NDPES) General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (General Permit).

California State Water Resources Control Board (SWRCB). 2024. Dewatering Discharge Notification Guidance available at https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html

U.S. Environmental Protection Agency (EPA). 2007. Developing Your Pollution Prevention Plan, EPA 833-R-06-004.

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Paving and Grinding Operations NS-3



Categories

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 Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

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Description and Purpose

Prevent or reduce the discharge of pollutants from paving operations, using measures to prevent runon and runoff pollution, properly disposing of wastes, and training employees and subcontractors.

The General Permit incorporates Numeric Action Levels (NAL) for pH and turbidity (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Many types of construction materials associated with paving and grinding operations, including mortar, concrete, and cement and their associated wastes have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows, which could lead to exceedances of the General Permit requirements.

Suitable Applications

These procedures are implemented where paving, surfacing, resurfacing, or sawcutting, may pollute stormwater runoff or discharge to the storm drain system or watercourses.

Limitations

- Paving opportunities may be limited during wet weather.
- Discharges of freshly paved surfaces may raise pH to environmentally harmful levels and trigger permit violations.

Implementation

General

- Avoid paving during the wet season when feasible.
- Reschedule paving and grinding activities if rain is forecasted.
- Train employees and sub-contractors in pollution prevention and reduction.
- Store materials away from drainage courses to prevent stormwater runon (see WM-1, Material Delivery and Storage).
- Protect drainage courses, particularly in areas with a grade, by employing BMPs to divert runoff or to trap and filter sediment.
- Stockpile material removed from roadways away from drain inlets, drainage ditches, and watercourses. These materials should be stored consistent with WM-3, Stockpile Management.
- Disposal of PCC (Portland cement concrete) and AC (asphalt concrete) waste should be in conformance with WM-8, Concrete Waste Management.

Saw Cutting, Grinding, and Pavement Removal

- Shovel or vacuum saw-cut slurry and remove from site. Cover or barricade storm drains during saw cutting to contain slurry.
- When paving involves AC, the following steps should be implemented to prevent the discharge of grinding residue, uncompacted or loose AC, tack coats, equipment cleaners, or unrelated paving materials:
  - AC grindings, pieces, or chunks used in embankments or shoulder backing should not be allowed to enter any storm drains or watercourses. Install inlet protection and perimeter controls until area is stabilized (i.e. cutting, grinding or other removal activities are complete and loose material has been properly removed and disposed of)or permanent controls are in place. Examples of temporary perimeter controls can be found in EC-9, Earth Dikes and Drainage Swales; SE-1, Silt Fence; SE-5, Fiber Rolls, or SE-13 Compost Socks and Berms
  - Collect and remove all broken asphalt and recycle when practical. Old or spilled asphalt should be recycled or disposed of properly.
- Do not allow saw-cut slurry to enter storm drains or watercourses. Residue from grinding operations should be picked up by a vacuum attachment to the grinding machine, or by sweeping, should not be allowed to flow across the pavement, and should not be left on the

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surface of the pavement. See also WM-8, Concrete Waste Management, and WM-10, Liquid Waste Management.

- Pavement removal activities should not be conducted in the rain.
- Collect removed pavement material by mechanical or manual methods. This material may be recycled for use as shoulder backing or base material.
- If removed pavement material cannot be recycled, transport the material back to an approved storage site.

Asphaltic Concrete Paving

- If paving involves asphaltic cement concrete, follow these steps:
  - Do not allow sand or gravel placed over new asphalt to wash into storm drains, streets, or creeks. Vacuum or sweep loose sand and gravel and properly dispose of this waste by referring to WM-5, Solid Waste Management.
  - Old asphalt should be disposed of properly. Collect and remove all broken asphalt from the site and recycle whenever possible.

Portland Cement Concrete Paving

- Do not wash sweepings from exposed aggregate concrete into a storm drain system. Collect waste materials by dry methods, such as sweeping or shoveling, and return to aggregate base stockpile or dispose of properly. Allow aggregate rinse to settle. Then, either allow rinse water to dry in a temporary pit as described in WM-8, Concrete Waste Management, or pump the water to the sanitary sewer if authorized by the local wastewater authority.

Sealing Operations

- During chip seal application and sweeping operations, petroleum or petroleum covered aggregate should not be allowed to enter any storm drain or water courses. Apply temporary perimeter controls until structure is stabilized (i.e. all sealing operations are complete and cured and loose materials have been properly removed and disposed).
- Inlet protection (SE-10, Storm Drain Inlet Protection) should be used during application of seal coat, tack coat, slurry seal, and fog seal.
- Seal coat, tack coat, slurry seal, or fog seal should not be applied if rainfall is predicted to occur during the application or curing period.

Paving Equipment

- Leaks and spills from paving equipment can contain toxic levels of heavy metals and oil and grease. Place drip pans or absorbent materials under paving equipment when not in use. Clean up spills with absorbent materials and dispose of in accordance with the applicable regulations. See NS-10, Vehicle and Equipment Maintenance, WM-4, Spill Prevention and Control, and WM-10, Liquid Waste Management.
- Substances used to coat asphalt transport trucks and asphalt spreading equipment should not contain soap and should be non-foaming and non-toxic.

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- Paving equipment parked onsite should be parked over plastic to prevent soil contamination.
- Clean asphalt coated equipment offsite whenever possible. When cleaning dry, hardened asphalt from equipment, manage hardened asphalt debris as described in WM-5, Solid Waste Management. Any cleaning onsite should follow NS-8, Vehicle and Equipment Cleaning.

Thermoplastic Striping

- Thermoplastic striper and pre-heater equipment shutoff valves should be inspected to ensure that they are working properly to prevent leaking thermoplastic from entering drain inlets, the stormwater drainage system, or watercourses.
- Pre-heaters should be filled carefully to prevent splashing or spilling of hot thermoplastic. Leave six inches of space at the top of the pre-heater container when filling thermoplastic to allow room for material to move.
- Do not pre-heat, transfer, or load thermoplastic near drain inlets or watercourses.
- Clean truck beds daily of loose debris and melted thermoplastic. When possible, recycle thermoplastic material.

Raised/Recessed Pavement Marker Application and Removal

- Do not transfer or load bituminous material near drain inlets, the stormwater drainage system, or watercourses.
- Melting tanks should be loaded with care and not filled to beyond six inches from the top to leave room for splashing.
- When servicing or filling melting tanks, ensure all pressure is released before removing lids to avoid spills.
- On large-scale projects, use mechanical or manual methods to collect excess bituminous material from the roadway after removal of markers.

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Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of paving and grinding operations.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Sample stormwater runoff required by the General Permit.
- Keep ample supplies of drip pans or absorbent materials onsite.
- Inspect and maintain machinery regularly to minimize leaks and drips.

References and Additional Resources

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.

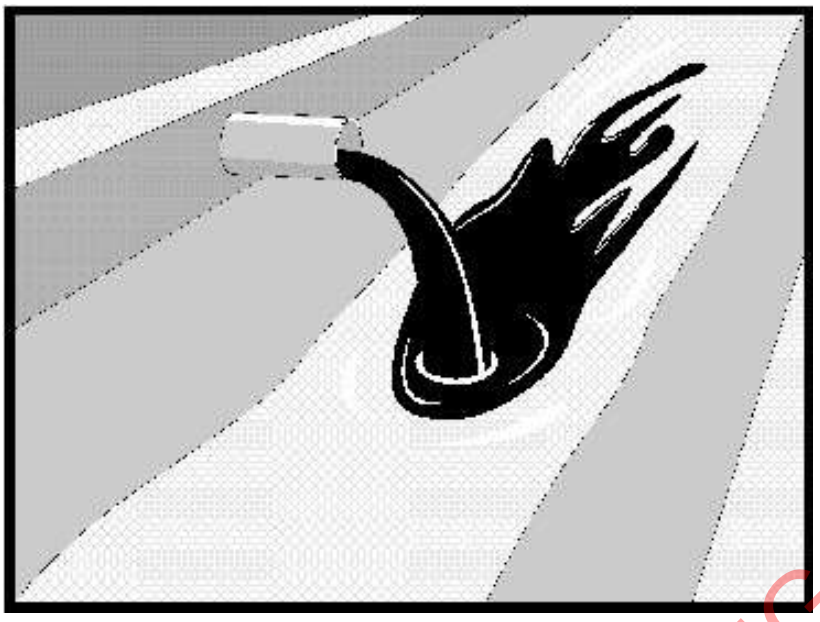
Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

Hot Mix Asphalt-Paving Handbook AC 150/5370-14, Appendix I, U.S. Army Corps of Engineers, July 1991.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

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Illicit Connection/Discharge NS-6



Categories		
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

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Description and Purpose

Procedures and practices designed for construction contractors to recognize illicit connections or illegally dumped or discharged materials on a construction site and report incidents.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Illicit connection/discharge and reporting is applicable anytime an illicit connection or discharge is discovered, or illegally dumped material is found on the construction site.

Limitations

Illicit connections and illegal discharges or dumping, for the purposes of this BMP, refer to discharges and dumping caused by parties other than the contractor. If pre-existing hazardous materials or wastes are known to exist onsite, they should be identified in the SWPPP and handled as set forth in the SWPPP.

Implementation

Planning

- Review the SWPPP. Pre-existing areas of contamination should be identified and documented in the SWPPP.
- Inspect site before beginning the job for evidence of illicit connections, illegal dumping or discharges. Document any pre-existing conditions and notify the owner.

- Inspect site regularly during project execution for evidence of illicit connections, illegal dumping or discharges.
- Observe site perimeter for evidence for potential of illicitly discharged or illegally dumped material, which may enter the job site.

Identification of Illicit Connections and Illegal Dumping or Discharges

- **General –** unlabeled and unidentifiable material should be treated as hazardous.
- **Solids -** Look for debris, or rubbish piles. Solid waste dumping often occurs on roadways with light traffic loads or in areas not easily visible from the traveled way.
- **Liquids -** signs of illegal liquid dumping or discharge can include:
  - Visible signs of staining or unusual colors to the pavement or surrounding adjacent soils
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Abnormal water flow during the dry weather season
- **Urban Areas -** Evidence of illicit connections or illegal discharges is typically detected at storm drain outfall locations or at manholes. Signs of an illicit connection or illegal discharge can include:
  - Abnormal water flow during the dry weather season
  - Unusual flows in sub drain systems used for dewatering
  - Pungent odors coming from the drainage systems
  - Discoloration or oily substances in the water or stains and residues detained within ditches, channels or drain boxes
  - Excessive sediment deposits, particularly adjacent to or near active offsite construction projects
- **Rural Areas -** Illicit connections or illegal discharges involving irrigation drainage ditches are detected by visual inspections. Signs of an illicit discharge can include:
  - Abnormal water flow during the non-irrigation season
  - Non-standard junction structures
  - Broken concrete or other disturbances at or near junction structures

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Reporting

Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery. For illicit connections or discharges to the storm drain system, notify the local stormwater management agency. For illegal dumping, notify the local law enforcement agency.

Cleanup and Removal

The responsibility for cleanup and removal of illicit or illegal dumping or discharges will vary by location. Contact the local stormwater management agency for further information.

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 BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect the site regularly to check for any illegal dumping or discharge.
- Prohibit employees and subcontractors from disposing of non-job-related debris or materials at the construction site.
- Notify the owner of any illicit connections and illegal dumping or discharge incidents at the time of discovery.

References and Additional Resources

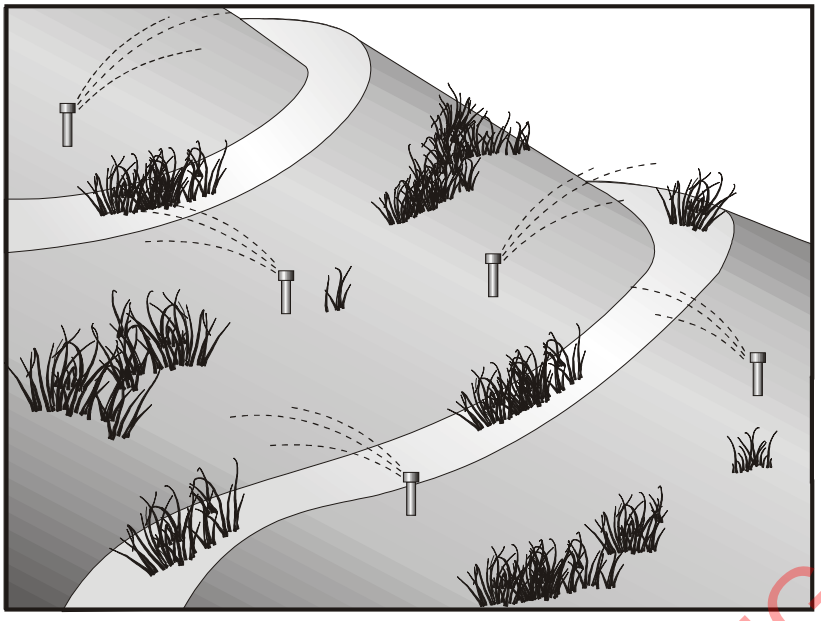
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Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

FOR BIDDING PURPOSES ONLY

Potable Water/Irrigation NS-7



Categories

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

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Description and Purpose

Potable Water/Irrigation consists of practices and procedures to manage the discharge of potential pollutants generated during discharges from irrigation water lines, landscape irrigation, lawn or garden watering, planned and unplanned discharges from potable water sources, water line flushing, and hydrant flushing.

Suitable Applications

Implement this BMP whenever potable water or irrigation water discharges occur at or enter a construction site.

Limitations

None identified.

Implementation

- Direct water from offsite sources around or through a construction site, where feasible, in a way that minimizes contact with the construction site.
- Discharges from water line flushing should be reused for landscaping purposes where feasible.
- Shut off the water source to broken lines, sprinklers, or valves as soon as possible to prevent excess water flow.
- Protect downstream stormwater drainage systems and watercourses from water pumped or bailed from trenches excavated to repair water lines.

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- Inspect irrigated areas within the construction limits for excess watering. Adjust watering times and schedules to ensure that the appropriate amount of water is being used and to minimize runoff. Consider factors such as soil structure, grade, time of year, and type of plant material in determining the proper amounts of water for a specific area.

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 BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Repair broken water lines as soon as possible.
- Inspect irrigated areas regularly for signs of erosion and/or discharge.

References and Additional Resources

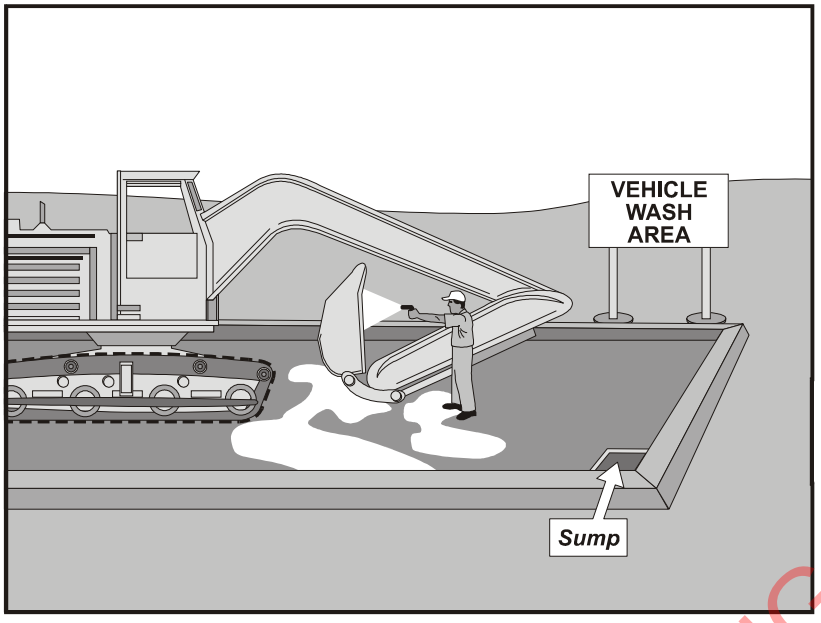
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Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

FOR BIDDING PURPOSES ONLY

Vehicle and Equipment Cleaning NS-8



Categories

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

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FOR BIDDING PURPOSES ONLY

Description and Purpose

Vehicle and equipment cleaning procedures and practices eliminate or reduce the discharge of pollutants to stormwater from vehicle and equipment cleaning operations. Procedures and practices include but are not limited to: using offsite facilities; washing in designated, contained areas only; eliminating discharges to the storm drain by infiltrating the wash water; and training employees and subcontractors in proper cleaning procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment cleaning is performed.

Limitations

Even phosphate-free, biodegradable soaps have been shown to be toxic to fish before the soap degrades. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/Exit.

Implementation

Other options to washing equipment onsite include contracting with either an offsite or mobile commercial washing business. These businesses may be better equipped to handle and dispose of the wash waters properly. Performing this work offsite can also be economical by eliminating the need for a separate washing operation onsite.

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If washing operations are to take place onsite, then:

- Use phosphate-free, biodegradable soaps.
- Educate employees and subcontractors on pollution prevention measures.
- Do not permit steam cleaning onsite. Steam cleaning can generate significant pollutant concentrates.
- Cleaning of vehicles and equipment with soap, solvents or steam should not occur on the project site unless resulting wastes are fully contained and disposed of. Resulting wastes should not be discharged or buried and must be captured and recycled or disposed according to the requirements of WM-10, Liquid Waste Management or WM-6, Hazardous Waste Management, depending on the waste characteristics. Minimize use of solvents. Use of diesel for vehicle and equipment cleaning is prohibited.
- All vehicles and equipment that regularly enter and leave the construction site must be cleaned offsite.
- When vehicle and equipment washing and cleaning must occur onsite, and the operation cannot be located within a structure or building equipped with appropriate disposal facilities, the outside cleaning area should have the following characteristics:
  - Located away from storm drain inlets, drainage facilities, or watercourses
  - Paved with concrete or asphalt and bermed to contain wash waters and to prevent runon and runoff
  - Configured with a sump to allow collection and disposal of wash water
  - No discharge of wash waters to storm drains or watercourses
  - Used only when necessary
- When cleaning vehicles and equipment with water:
  - Use as little water as possible. High-pressure sprayers may use less water than a hose and should be considered
  - Use positive shutoff valve to minimize water usage
  - Facility wash racks should discharge to a sanitary sewer, recycle system or other approved discharge system and must not discharge to the storm drainage system, watercourses, or to groundwater

FOR BIDDING PURPOSES ONLY

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 BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Inspection and maintenance are minimal, although some berm repair may be necessary.
- Monitor employees and subcontractors throughout the duration of the construction project to ensure appropriate practices are being implemented.
- Inspect sump regularly and remove liquids and sediment as needed.
- Prohibit employees and subcontractors from washing personal vehicles and equipment on the construction site.

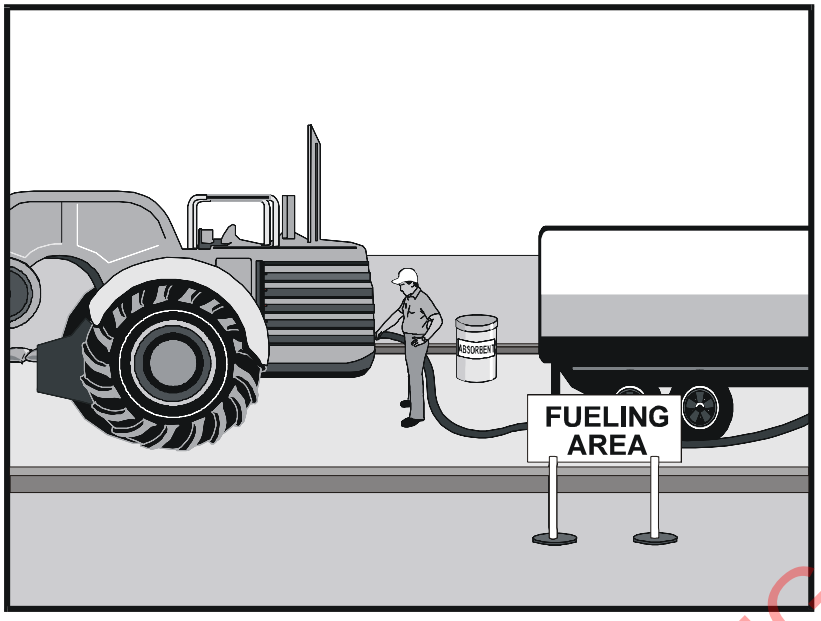
References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

Swisher, R.D. Surfactant Biodegradation, Marcel Decker Corporation, 1987.

FOR BIDDING PURPOSES ONLY

Vehicle and Equipment Fueling NS-9



Categories

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

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FOR BIDDING PURPOSES ONLY

Description and Purpose

Vehicle equipment fueling procedures and practices are designed to prevent fuel spills and leaks and reduce or eliminate contamination of stormwater. This can be accomplished by using offsite facilities, fueling in designated areas only, enclosing or covering stored fuel, implementing spill controls, and training employees and subcontractors in proper fueling procedures.

Suitable Applications

These procedures are suitable on all construction sites where vehicle and equipment fueling takes place.

Limitations

Onsite vehicle and equipment fueling should only be used where it is impractical to send vehicles and equipment offsite for fueling. Sending vehicles and equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/ Exit.

Implementation

- Use offsite fueling stations as much as possible. These businesses are better equipped to handle fuel and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate fueling area at a site.
- Discourage “topping-off” of fuel tanks.

- Absorbent spill cleanup materials and spill kits should be available in fueling areas and on fueling trucks and should be disposed of properly after use.
- Drip pans or absorbent pads should be used during vehicle and equipment fueling, unless the fueling is performed over an impermeable surface in a dedicated fueling area.
- Use absorbent materials on small spills. Do not hose down or bury the spill. Remove the adsorbent materials promptly and dispose of properly.
- Avoid mobile fueling of mobile construction equipment around the site; rather, transport the equipment to designated fueling areas. With the exception of tracked equipment such as bulldozers and large excavators, most vehicles should be able to travel to a designated area with little lost time.
- Train employees and subcontractors in proper fueling and cleanup procedures.
- When fueling must take place onsite, designate an area away from drainage courses to be used. Fueling areas should be identified in the SWPPP.
- Dedicated fueling areas should be protected from stormwater runon and runoff and should be located at least 50 ft away from downstream drainage facilities and watercourses. Fueling must be performed on level-grade areas.
- Protect fueling areas with berms and dikes to prevent runon, runoff, and to contain spills.
- Nozzles used in vehicle and equipment fueling should be equipped with an automatic shutoff to control drips. Fueling operations should not be left unattended.
- Use vapor recovery nozzles to help control drips as well as air pollution where required by Air Quality Management Districts (AQMD).
- Federal, state, and local requirements should be observed for any stationary above ground storage tanks.

FOR BIDDING PURPOSES ONLY

Inspection and Maintenance

- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Vehicles and equipment should be inspected each day of use for leaks. Leaks should be repaired immediately, or problem vehicles or equipment should be removed from the project site.
- Keep ample supplies of spill cleanup materials onsite.
- Immediately clean up spills and properly dispose of contaminated soil and cleanup materials.

References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

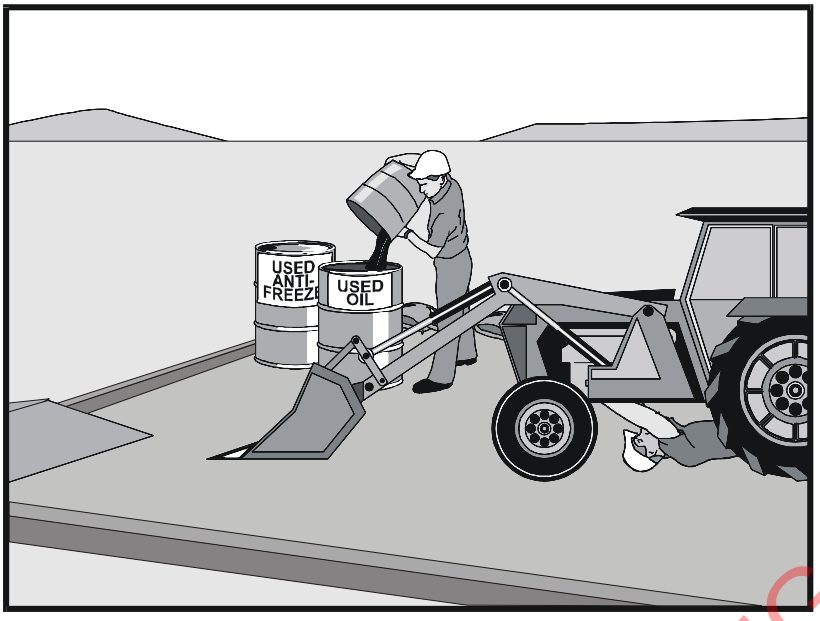
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Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

FOR BIDDING PURPOSES ONLY

Vehicle & Equipment Maintenance NS-10



Categories

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

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Description and Purpose

Prevent or reduce the contamination of stormwater resulting from vehicle and equipment maintenance by running a "dry and clean site". The best option would be to perform maintenance activities at an offsite facility. If this option is not available then work should be performed in designated areas only, while providing cover for materials stored outside, checking for leaks and spills, and containing and cleaning up spills immediately. Employees and subcontractors must be trained in proper procedures.

FOR BIDDING PURPOSES ONLY

Suitable Applications

These procedures are suitable on all construction projects where an onsite yard area is necessary for storage and maintenance of heavy equipment and vehicles.

Limitations

Onsite vehicle and equipment maintenance should only be used where it is impractical to send vehicles and equipment offsite for maintenance and repair. Sending vehicles/equipment offsite should be done in conjunction with TC-1, Stabilized Construction Entrance/Exit.

Outdoor vehicle or equipment maintenance is a potentially significant source of stormwater pollution. Activities that can contaminate stormwater include engine repair and service, changing or replacement of fluids, and outdoor equipment storage and parking (engine fluid leaks). For further information on vehicle or equipment servicing, see NS-8,

Vehicle and Equipment Cleaning, and NS-9, Vehicle and Equipment Fueling.

Implementation

- Use offsite repair shops as much as possible. These businesses are better equipped to handle vehicle fluids and spills properly. Performing this work offsite can also be economical by eliminating the need for a separate maintenance area.
- If maintenance must occur onsite, use designated areas, located away from drainage courses. Dedicated maintenance areas should be protected from stormwater runon and runoff and should be located at least 50 ft from downstream drainage facilities and watercourses.
- Drip pans or absorbent pads should be used during vehicle and equipment maintenance work that involves fluids, unless the maintenance work is performed over an impermeable surface in a dedicated maintenance area.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- All fueling trucks and fueling areas are required to have spill kits and/or use other spill protection devices.
- Use adsorbent materials on small spills. Remove the absorbent materials promptly and dispose of properly.
- Inspect onsite vehicles and equipment daily at startup for leaks, and repair immediately.
- Keep vehicles and equipment clean; do not allow excessive build-up of oil and grease.
- Segregate and recycle wastes, such as greases, used oil or oil filters, antifreeze, cleaning solutions, automotive batteries, hydraulic and transmission fluids. Provide secondary containment and covers for these materials if stored onsite.
- Train employees and subcontractors in proper maintenance and spill cleanup procedures.
- Drip pans or plastic sheeting should be placed under all vehicles and equipment placed on docks, barges, or other structures over water bodies when the vehicle or equipment is planned to be idle for more than 1 hour.
- For long-term projects, consider using portable tents or covers over maintenance areas if maintenance cannot be performed offsite.
- Consider use of new, alternative greases and lubricants, such as adhesive greases, for chassis lubrication and fifth-wheel lubrication.
- Properly dispose of used oils, fluids, lubricants, and spill cleanup materials.
- Do not place used oil in a dumpster or pour into a storm drain or watercourse.
- Properly dispose of or recycle used batteries.
- Do not bury used tires.

FOR BIDDING PURPOSES ONLY

- Repair leaks of fluids and oil immediately.

Listed below is further information if you must perform vehicle or equipment maintenance onsite.

Safer Alternative Products

- Consider products that are less toxic or hazardous than regular products. These products are often sold under an "environmentally friendly" label.
- Consider use of grease substitutes for lubrication of truck fifth-wheels. Follow manufacturers label for details on specific uses.
- Consider use of plastic friction plates on truck fifth-wheels in lieu of grease. Follow manufacturers label for details on specific uses.

Waste Reduction

Parts are often cleaned using solvents such as trichloroethylene, trichloroethane, or methylene chloride. Many of these cleaners are listed in California Toxic Rule as priority pollutants. These materials are harmful and must not contaminate stormwater. They must be disposed of as a hazardous waste. Reducing the number of solvents makes recycling easier and reduces hazardous waste management costs. Often, one solvent can perform a job as well as two different solvents. Also, if possible, eliminate or reduce the amount of hazardous materials and waste by substituting non-hazardous or less hazardous materials. For example, replace chlorinated organic solvents with non-chlorinated solvents. Non-chlorinated solvents like kerosene or mineral spirits are less toxic and less expensive to dispose of properly. Check the list of active ingredients to see whether it contains chlorinated solvents. The "chlor" term indicates that the solvent is chlorinated. Also, try substituting a wire brush for solvents to clean parts.

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Recycling and Disposal

Separating wastes allows for easier recycling and may reduce disposal costs. Keep hazardous wastes separate, do not mix used oil solvents, and keep chlorinated solvents (like,-trichloroethane) separate from non-chlorinated solvents (like kerosene and mineral spirits). Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around. Provide cover and secondary containment until these materials can be removed from the site.

Oil filters can be recycled. Ask your oil supplier or recycler about recycling oil filters.

Do not dispose of extra paints and coatings by dumping liquid onto the ground or throwing it into dumpsters. Allow coatings to dry or harden before disposal into covered dumpsters.

Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries, even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

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 BMPs

in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Keep ample supplies of spill cleanup materials onsite.
- Maintain waste fluid containers in leak proof condition.
- Vehicles and equipment should be inspected on each day of use. Leaks should be repaired immediately, or the problem vehicle(s) or equipment should be removed from the project site.
- Inspect equipment for damaged hoses and leaky gaskets routinely. Repair or replace as needed.

References and Additional Resources

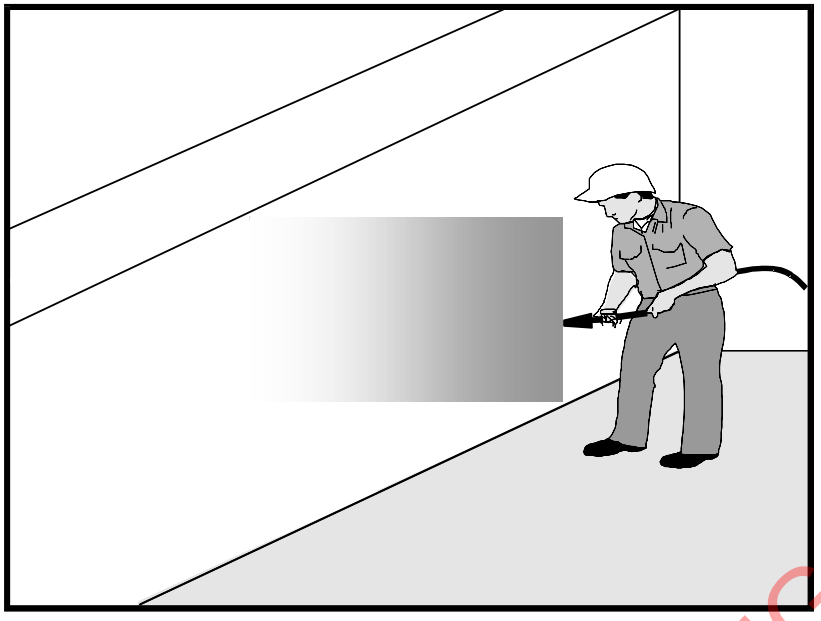
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Coastal Nonpoint Pollution Control Program; Program Development and Approval Guidance, Working Group, Working Paper; USEPA, April 1992.

FOR BIDDING PURPOSES ONLY

Concrete Curing NS-12



Categories

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 Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	

Potential Alternatives

None

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FOR BIDDING PURPOSES ONLY

Description and Purpose

Concrete curing is used in the construction of structures such as bridges, retaining walls, pump houses, large slabs, and structured foundations. Concrete curing includes the use of both chemical and water methods.

Concrete and its associated curing materials have basic chemical properties that can raise the pH of water to levels outside of the permitted range. Discharges of stormwater and non-stormwater exposed to concrete during curing may have a high pH and may contain chemicals, metals, and fines. The General Permit incorporates Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Proper procedures and care should be taken when managing concrete curing materials to prevent them from coming into contact with stormwater flows, which could result in a high pH discharge.

Suitable Applications

Suitable applications include all projects where Portland Cement Concrete (PCC) and concrete curing chemicals are placed where they can be exposed to rainfall, runoff from other areas, or where runoff from the PCC will leave the site.

Limitations

- Runoff contact with concrete waste can raise pH levels in the water to environmentally harmful levels and trigger permit violations.

Implementation

Chemical Curing

- Avoid over spray of curing compounds.
- Minimize the drift by applying the curing compound close to the concrete surface. Apply an amount of compound that covers the surface but does not allow any runoff of the compound.
- Use proper storage and handling techniques for concrete curing compounds. Refer to WM-1, Material Delivery and Storage.
- Protect drain inlets prior to the application of curing compounds.
- Refer to WM-4, Spill Prevention and Control.

Water Curing for Bridge Decks, Retaining Walls, and other Structures

- Direct cure water away from inlets and watercourses to collection areas for evaporation or other means of removal in accordance with all applicable permits. See WM-8 Concrete Waste Management.
- Collect cure water at the top of slopes and transport to a concrete waste management area in a non-erosive manner. See EC-9 Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.
- Utilize wet blankets or a similar method that maintains moisture while minimizing the use and possible discharge of water.

Education

- Educate employees, subcontractors, and suppliers on proper concrete curing techniques to prevent contact with discharge as described herein.
- Arrange for the QSP or the appropriately trained contractor's superintendent or representative to oversee and enforce concrete curing procedures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Sample non-stormwater discharges and stormwater runoff that contacts uncured and partially cured concrete as required by the General Permit.

FOR BIDDING PURPOSES ONLY

- Ensure that employees and subcontractors implement appropriate measures for storage, handling, and use of curing compounds.
- Inspect cure containers and spraying equipment for leaks.

References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

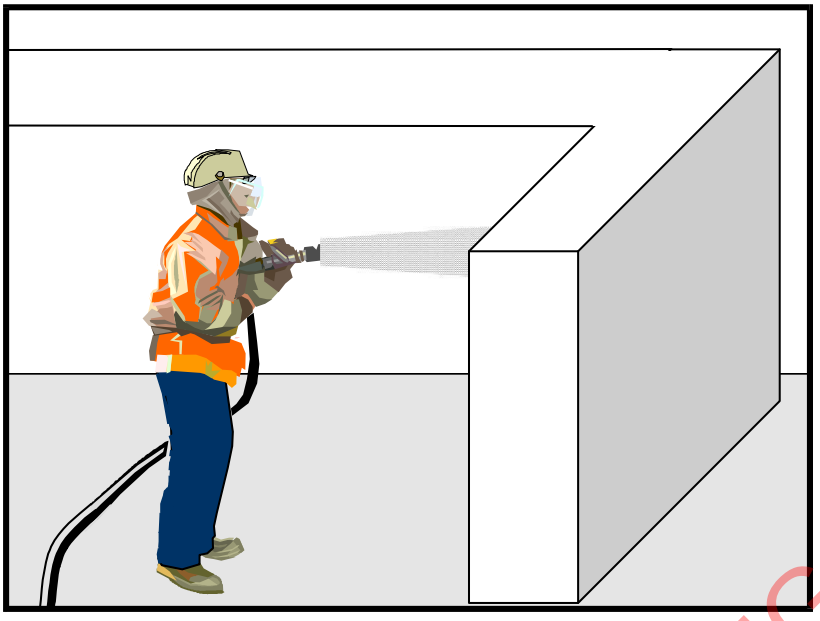
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Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

FOR BIDDING PURPOSES ONLY

Concrete Finishing NS-13



Categories

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 Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	☑

Potential Alternatives

None

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FOR BIDDING PURPOSES ONLY

Description and Purpose

Concrete finishing methods are used for bridge deck rehabilitation, paint removal, curing compound removal, and final surface finish appearances. Methods include sand blasting, shot blasting, grinding, or high-pressure water blasting. Stormwater and non-stormwater exposed to concrete finishing by-products may have a high pH and may contain chemicals, metals, and fines. Proper procedures and implementation of appropriate BMPs can minimize the impact that concrete-finishing methods may have on stormwater and non-stormwater discharges.

The General Permit incorporates Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Concrete and its associated curing materials have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows, which could lead to exceedances of the General Permit requirements.

Suitable Applications

These procedures apply to all construction locations where concrete finishing operations are performed.

Limitations

- Runoff contact with concrete waste can raise pH levels in the water to environmentally harmful levels and trigger permit violations.

Implementation

- Collect and properly dispose of water from high-pressure water blasting operations.
- Collect contaminated water from blasting operations at the top of slopes. Transport or dispose of contaminated water while using BMPs such as those for erosion control. Refer to EC-9, Earth Dikes and Drainage Swales, EC-10, Velocity Dissipation Devices, and EC-11, Slope Drains.
- Direct water from blasting operations away from inlets and watercourses to collection areas for infiltration or other means of removal (dewatering). Refer to NS-2 Dewatering Operations.
- Protect inlets during sandblasting operations. Refer to SE-10, Storm Drain Inlet Protection.
- Refer to WM-8, Concrete Waste Management for disposal of concrete debris.
- Minimize the drift of dust and blast material as much as possible by keeping the blasting nozzle close to the surface.
- When blast residue contains a potentially hazardous waste, refer to WM-6, Hazardous Waste Management.

Education

- Educate employees, subcontractors, and suppliers on proper concrete finishing techniques to prevent contact with discharge as described herein.
- Arrange for the QSP or the appropriately trained contractor's superintendent or representative to oversee and enforce concrete finishing procedures.

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharges daily while non-stormwater discharges occur.
- Sample non-stormwater discharges and stormwater runoff that contacts concrete dust and debris as required by the General Permit.
- Sweep or vacuum up debris from sandblasting at the end of each shift.

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- At the end of each work shift, remove and contain liquid and solid waste from containment structures, if any, and from the general work area.
- Inspect containment structures for damage prior to use and prior to onset of forecasted rain.

References and Additional Resources

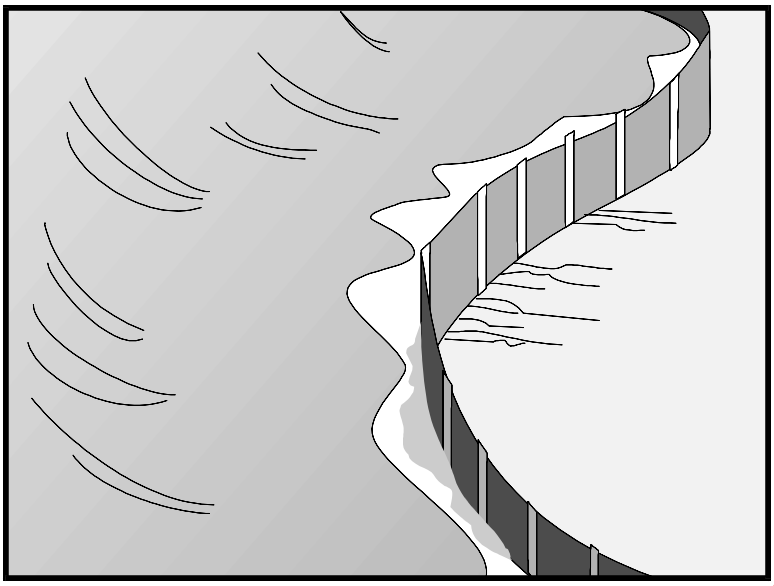
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Stormwater Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices, EPA 832-R-92005; USEPA, April 1992.

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Silt Fence SE-1



Categories

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 Category**

☒ **Secondary Category**

Description and Purpose

A silt fence is made of a woven geotextile that has been entrenched, attached to supporting poles, and sometimes backed by a plastic or wire mesh for support. The silt fence detains water, promoting sedimentation of coarse sediment behind the fence. Silt fence does not retain soil fine particles like clays or silts.

Suitable Applications

Silt fences are suitable for perimeter control, placed below areas where sheet flows discharge from the site. They could also be used as interior controls below disturbed areas where runoff may occur in the form of sheet and rill erosion and around inlets within disturbed areas (Storm Drain Inlet Protection, SE-10). Silt fences should not be used in locations where the flow is concentrated. Silt fences should always be used in combination with erosion controls. Suitable applications include:

- At perimeter of a project (although they should not be installed up and down slopes).
- Below the toe or down slope of exposed and erodible slopes.
- Along streams and channels.
- Around temporary spoil areas and stockpiles.
- Around inlets.
- Below other small cleared areas.

Targeted Constituents

Sediment (coarse sediment)	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-5 Fiber Rolls

SE-6 Gravel Bag Berm SE-12 Manufactured Linear Sediment Controls

SE-13 Compost Socks and Berms

SE-14 Biofilter Bags

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Limitations

- Do not use in streams, channels, drain inlets, or anywhere flow is concentrated.
- Do not use in locations where ponded water may cause a flooding hazard.
- Do not use silt fence to divert water flows or place across any contour line.
- Improperly installed fences are subject to failure from undercutting, overtopping, or collapsing.
- Must be trenched and keyed in.
- According to the State Water Board's *CGP Review, Issue #2* (2014), silt fences reinforced with metal or plastic mesh should be avoided due to plastic pollution and wildlife concerns.
- Not intended for use as a substitute for Fiber Rolls (SE-5), when fiber rolls are being used as a slope interruption device.
- Do not use on slopes subject to creeping, slumping, or landslides.

Implementation

General

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

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The following layout and installation guidance can improve performance and should be followed:

- Silt fence should be used in combination with erosion controls up-slope in order to provide the most effective sediment control.
- Silt fence alone is not effective at reducing turbidity. (Barrett and Malina, 2004)
- Designers should consider diverting sediment laden water to a temporary sediment basin or trap. (EPA, 2012)
- Use principally in areas where sheet flow occurs.
- Install along a level contour, so water does not pond more than 1.5 ft. at any point along the silt fence.
- 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.
- Efficiency of silt fences is primarily dependent on the detention time of the runoff behind the control. (Barrett and Malina, 2004)

- The drainage area above any fence should not exceed a quarter of an acre. (Rule of Thumb-100-feet of silt fence per 10,000 ft.^{2} of disturbed area.) (EPA, 2012)
- The maximum length of slope draining to any point along the silt fence should be 100 ft. per ft of silt 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 draining to the silt fence is permanently stabilized, after which, the silt fence fabric and posts should be removed and properly disposed.
- J-hooks, which have ends turning up the slope to break up long runs of fence and provide multiple storage areas that work like mini-retention areas, may be used to increase the effectiveness of silt fence.
- Be aware of local regulations regarding the type and installation requirements of silt fence, which may differ from those presented in this fact sheet.

Design and Layout

In areas where high winds are anticipated the fence should be supported by a plastic or wire mesh. The geotextile fabric of the silt fence should contain ultraviolet inhibitors and stabilizers to provide longevity equivalent to the project life or replacement schedule.

- Layout in accordance with the attached figures.
- For slopes that contain a high number of rocks or large dirt clods that tend to dislodge, it may be necessary to protect silt fence from rocks (e.g., rockfall netting) ensure the integrity of the silt fence installation.

Standard vs. Heavy Duty Silt Fence

Standard Silt Fence

- Generally applicable in cases where the area draining to fence produces moderate sediment loads.

Heavy Duty Silt Fence

- Heavy duty silt fence usually has 1 or more of the following characteristics, not possessed by standard silt fence.
  - Fabric is reinforced with wire backing or additional support.
  - Posts are spaced closer than pre-manufactured, standard silt fence products.
- Use is generally limited to areas affected by high winds.
- Area draining to fence produces moderate sediment loads.

Materials

Standard Silt Fence

- Silt fence material should be woven geotextile with a minimum width of 36 in. The fabric should conform to the requirements in ASTM designation D6461.

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- Wooden 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.

Heavy-Duty Silt Fence

- Some silt fence has a wire backing to provide additional support, and there are products that may use prefabricated plastic holders for the silt fence and use metal posts instead of wood stakes.

Installation Guidelines – Traditional Method

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 of the proposed silt fence (trenches should not be excavated wider or deeper than necessary for proper silt fence installation).

- 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 geotextile 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 geotextile and closer post spacing are used, the mesh support fence may be eliminated.

- Woven geotextile should be purchased in a long roll, then cut to the length of the barrier. When joints are necessary, geotextile 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 native material and compacted.

- 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.

- Cross barriers should be a minimum of 1/3 and a maximum of ½ the height of the linear barrier.

- See typical installation details at the end of this fact sheet.

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Installation Guidelines - Static Slicing Method

- Static Slicing is defined as insertion of a narrow blade pulled behind a tractor, similar to a plow blade, at least 10 in. into the soil while at the same time pulling silt geotextile fabric into the ground through the opening created by the blade to the depth of the blade. Once the geotextile is installed, the soil is compacted using tractor tires.
- This method will not work with pre-fabricated, wire backed silt fence.
- Benefits:
    - Ease of installation (most often done with a 2-person crew).
    - Minimal soil disturbance.
    - Better level of compaction along fence, less susceptible to undercutting
    - Uniform installation.
- Limitations:
    - Does not work in shallow or rocky soils.
    - Complete removal of geotextile material after use is difficult.
    - Be cautious when digging near potential underground utilities.

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Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- 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, and replaced with new silt fence barriers.
- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches 1/3 of the barrier height.
- Silt fences should be left in place until the upgradient area is permanently stabilized. Until then, the silt fence should be inspected and maintained regularly.
- Remove silt fence when upgradient areas are stabilized. Fill and compact post holes and anchor trench, remove sediment accumulation, grade fence alignment to blend with adjacent ground, and stabilize disturbed area.

References and Additional Resources

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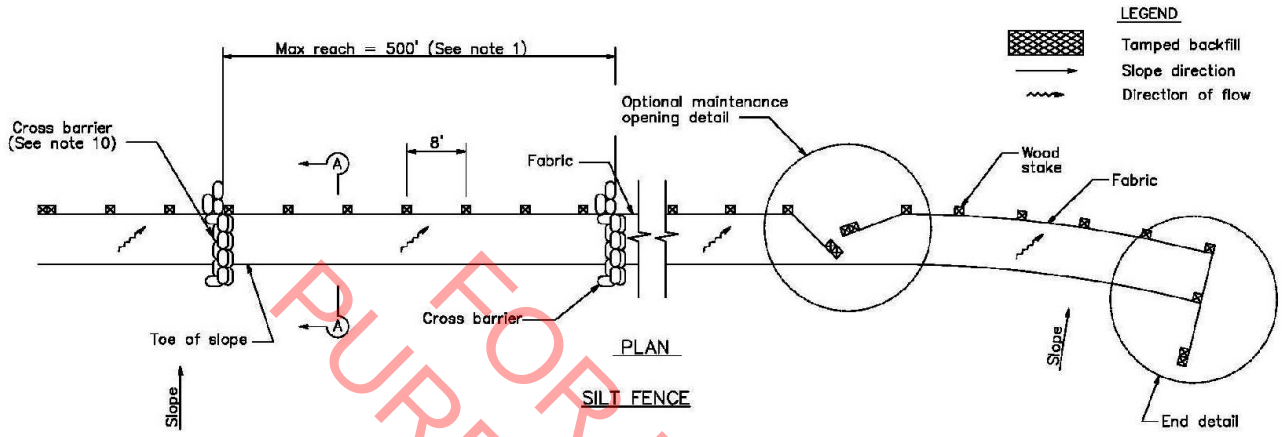
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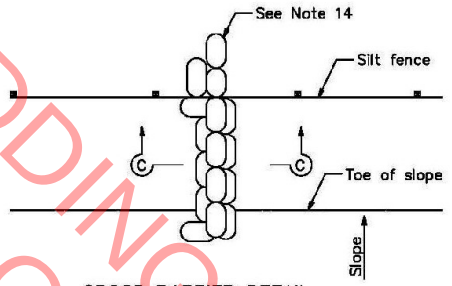
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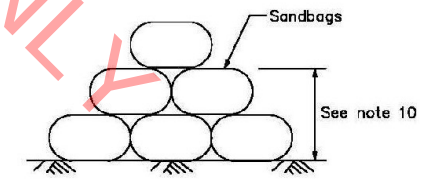


PLAN

SILT FENCE



CROSS BARRIER DETAIL

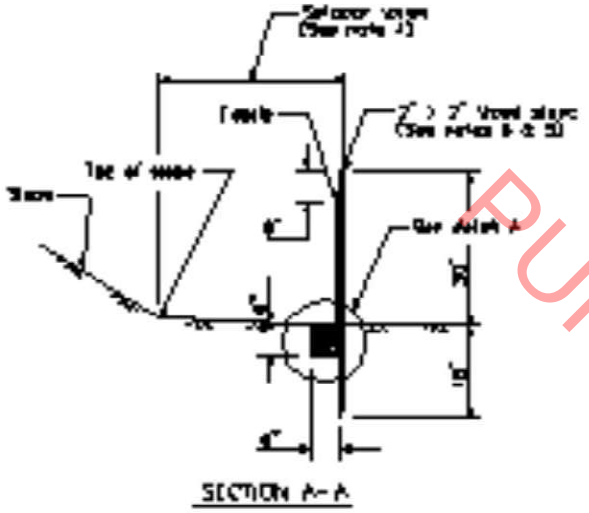


SECTION C–C

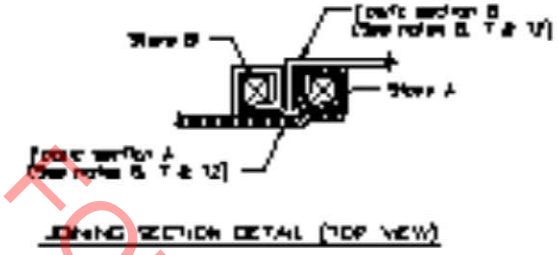
NOTES

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.
14. Add 3–4 bags to cross barrier on downgradient side of silt fence as needed to prevent bypass or undermining and as allowable based on site limits of disturbance.

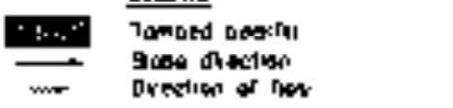
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SECTION A-A

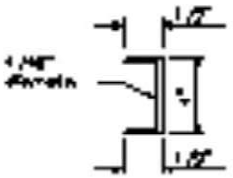


JOINING SECTION DETAIL (TOP VIEW)

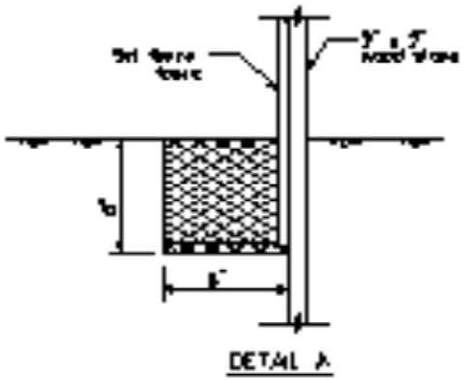




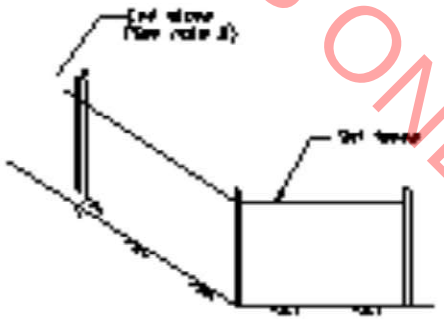
END STAKE DETAIL (TOP VIEW)



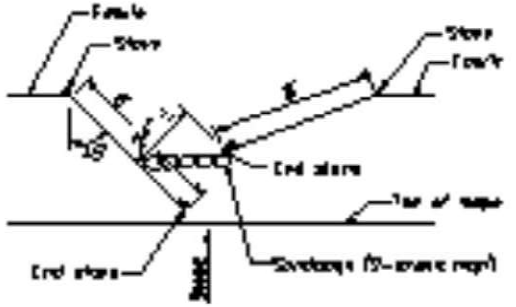
STAPLE DETAIL
(SEE NOTE 9)



DETAIL A

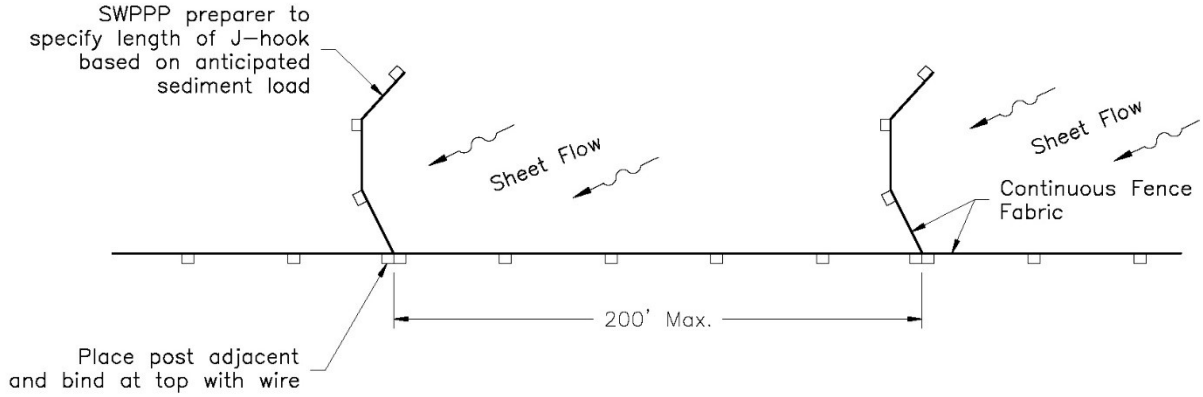


END DETAIL



OPTIONAL MAINTENANCE OPENING DETAIL
(SEE NOTE 11)

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Plan

J–HOOK

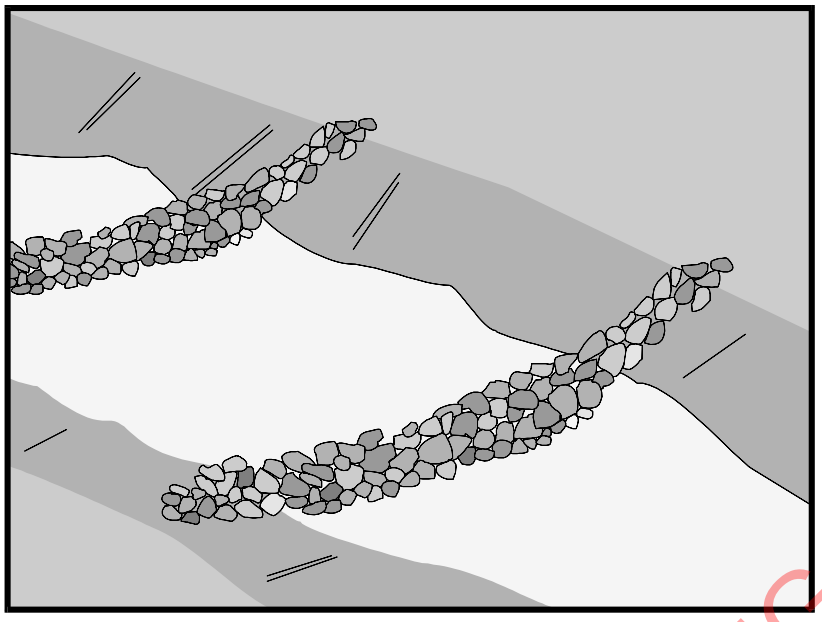


Plan

J–HOOK

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Check Dams SE-4



Categories

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 Category**
☒ **Secondary Category**

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-12 Manufactured Linear Sediment Controls
- SE-14 Biofilter Bags

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Description and Purpose

A check dam is a small barrier constructed of rock, gravel bags, sandbags, fiber rolls, or other proprietary products, placed across a constructed swale or drainage ditch. Check dams reduce the effective slope of the channel, thereby reducing scour and channel erosion by reducing flow velocity and increasing residence time within the channel, allowing sediment to settle.

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.
- To act as a grade control structure.

Limitations

- Not to be used in live streams or in channels with extended base flows.
- Not appropriate in channels that drain areas greater than 10 acres.
- Not appropriate in channels that are already grass-lined unless erosion potential or sediment-laden flow 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.
- Do not construct check dams with straw bales or silt fence.
- Water suitable for mosquito production may stand behind check dams, particularly if subjected to daily non-stormwater discharges.

Implementation

General

Check dams reduce the effective slope and create small pools in swales and ditches that drain 10 acres or less. Using check dams to reduce channel slope reduces the velocity of stormwater flows, thus reducing erosion of the swale or ditch and promoting sedimentation. Thus, check dams are dual-purpose and serve an important role as erosion controls as well as sediment controls. Note that use of 1-2 isolated 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.

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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 should 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, either:

- Don't use check dams. Consider alternative BMPs, or.
- 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 (see "Spacing Between Check Dams" detail at the end of this fact sheet). The center section of the dam should be lower than the edge sections (at least 6 inches), acting as a spillway, so that the check dam will direct flows to the center of

the ditch or swale (see "Typical Rock Check Dam" detail at the end of this fact sheet). Bypass or side-cutting can occur if a sufficient spillway is not provided in the center of the dam.

Check dams are usually constructed of rock, gravel bags, sandbags, and fiber rolls. A number of products can also be used as check dams (e.g. HDPE check dams, temporary silt dikes (SE-12)), 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. 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 should completely span the ditch or swale to prevent washout. The rock used should be large enough to stay in place given the expected design flow through the channel. It is recommended that abutments be extended 18 in. into the channel bank. Rock can be graded such that smaller diameter rock (e.g. 2-4 in) is located on the upstream side of larger rock (holding the smaller rock in place); increasing residence time.

Log check dams are usually constructed of 4 to 6 in. diameter logs, installed vertically. 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.

See fiber rolls, SE-5, for installation of fiber roll check dams.

Gravel bag and sand bag 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 (see "Gravel Bag Check Dam" detail at the end of this fact sheet).

Manufactured products, such as temporary silt dikes (SE-12), should be installed in accordance with the manufacturer's instructions. Installation typically requires anchoring or trenching of products, as well as regular maintenance to remove accumulated sediment and debris.

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.
- For multiple check dam installation, 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 should be cleaned following each storm event.

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- 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.

Materials

- Rock used for check dams should typically be 8-12 in rock and be sufficiently sized to stay in place given expected design flows in the channel. Smaller diameter rock (e.g. 2 to 4 in) can be placed on the upstream side of larger rock to increase residence time.
- 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.
- Temporary silt dikes used for check dams should conform to SE-12, Temporary Silt Dikes.

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 (pyramid approach). Gravel bags and sandbags should not be stacked any higher than 3 ft.
- Upper rows or gravel and sand bags shall overlap joints in lower rows.
- Fiber rolls should be trenched in, backfilled, and firmly staked in place.
- Install along a level contour.
- HDPE check dams, temporary silt dikes, and other manufactured products should be used and installed per manufacturer specifications.

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Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Replace missing rock, bags, rolls, etc. Replace bags or rolls that have degraded or have become damaged.
- If the check dam is used as a sediment capture device, sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.

- 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.
- Inspect areas behind check dams for pools of standing water, especially if subjected to daily non-stormwater discharges.
- Remove accumulated sediment prior to permanent seeding or soil stabilization.
- Remove check dam and accumulated sediment when check dams are no longer needed.

References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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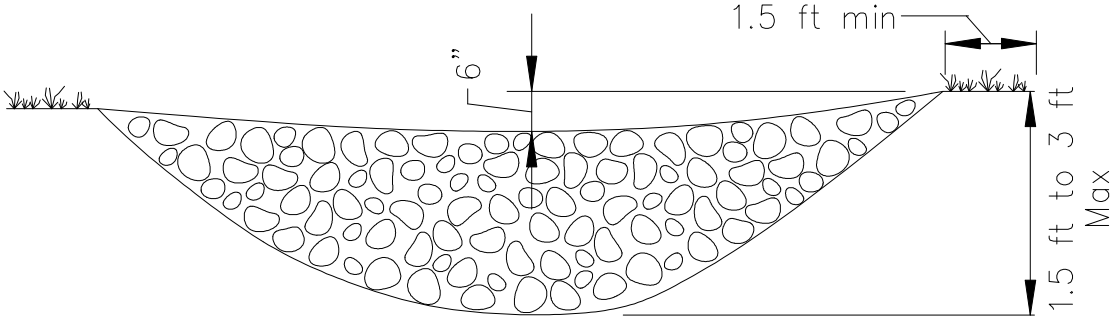
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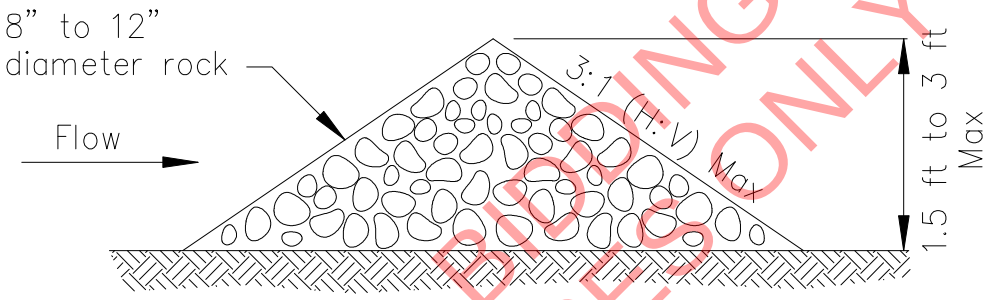
Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Metzger, M.E. 2004. Managing mosquitoes in stormwater treatment devices. University of California Division of Agriculture and Natural Resources, Publication 8125. On-line: http://anrcatalog.ucdavis.edu/pdf/8125.pdf

FOR BIDDING PURPOSES ONLY



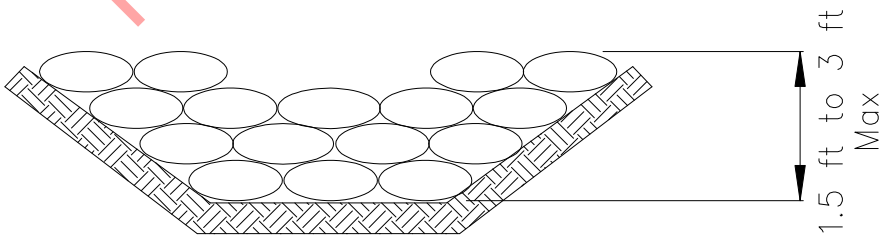
ELEVATION



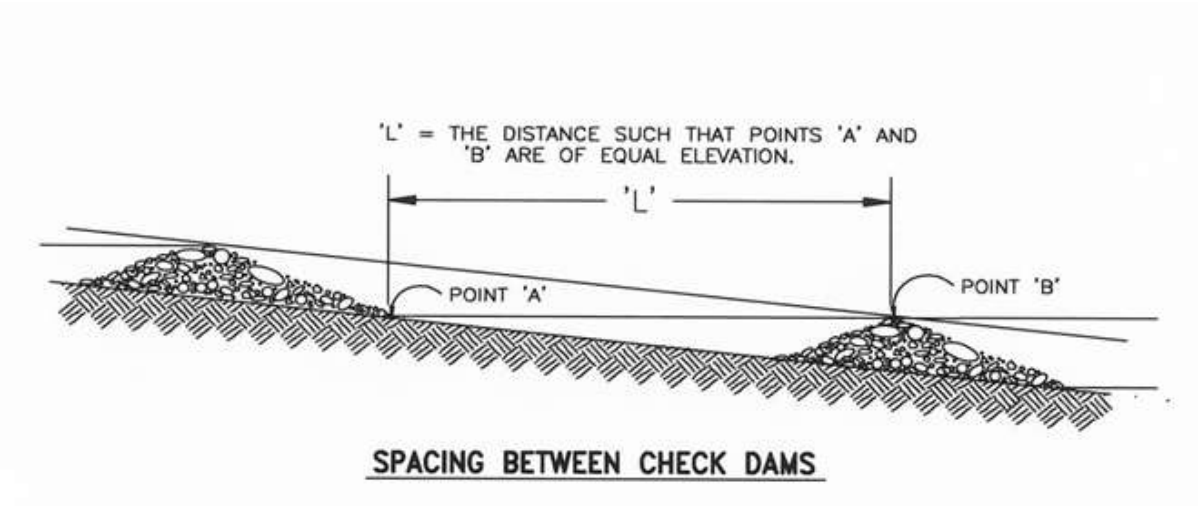
TYPICAL ROCK CHECK DAM SECTION

ROCK CHECK DAM
NOT TO SCALE

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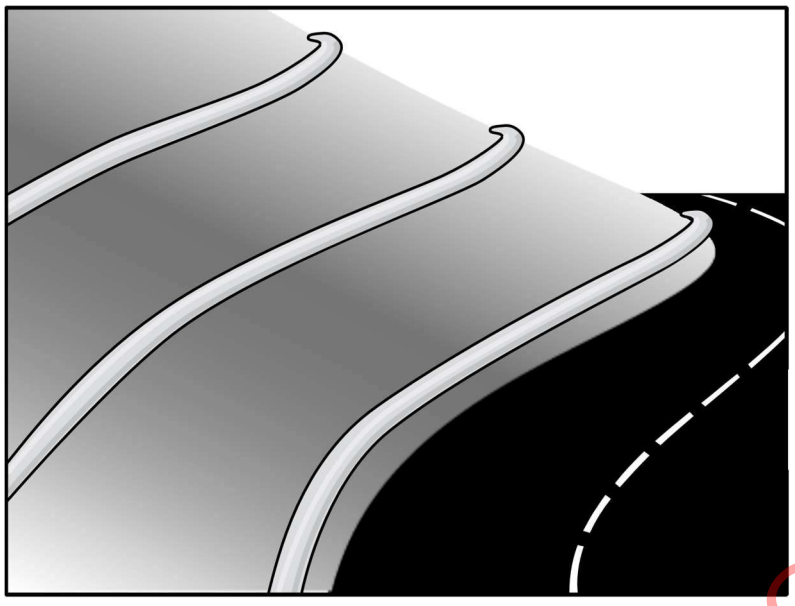
GRAVEL BAG CHECK DAM ELEVATION
NOT TO SCALE



SPACING BETWEEN CHECK DAMS

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Fiber Rolls SE-5



Categories

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 Category**
☒ **Secondary Category**

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-12 Manufactured Linear Sediment Controls
- SE-13 Compost Socks and Berms
- SE-14 Biofilter Bags

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Description and Purpose

A fiber roll (also known as a wattle or log) consists of straw, coir, curled wood fiber, or other biodegradable materials bound into a tight tubular roll wrapped by netting. Additionally, gravel core fiber rolls are available, which contain an imbedded ballast material such as gravel or sand for additional weight, when staking the rolls are not feasible (such as use as inlet protection).

When fiber rolls are placed at the top, toe, and on the face of slopes along the contours, fiber rolls intercept runoff, reduce flow velocity, release runoff as sheet flow, and provide sediment removal from the runoff (through sedimentation). By interrupting the length of a slope, fiber rolls can also reduce sheet and rill erosion until vegetation is established.

Suitable Applications

Fiber rolls may be suitable:

- Along the top, toe, 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 with minimal grade.
- Down-slope of exposed soil areas.

- At operational storm drains as a form of inlet protection.
- Around temporary stockpiles.

Limitations

- Fiber rolls are to be used in conjunction with erosion control, such as hydroseed, mulch, rolled erosion control products (RECPs), etc.
- Only biodegradable fiber rolls containing no plastic can remain on a site when applying for a Notice of Termination (NOT) due to plastic pollution and wildlife concerns. There may be further limitations on the use of plastic wrapped fiber rolls in wildlife sensitive areas. Fiber rolls containing plastic must be removed and disposed of prior to final stabilization.
- Do not install fiber rolls in high traffic areas where vehicles and equipment will displace or damage them.
- Do not use fiber rolls on paved surfaces where they cannot be staked and trenched in. Only gravel core rolls may be effective in this situation. See Gravel Bags (SE-6), Manufactured Linear Sediment Controls (SE-12), Compost Socks and Berms (SE-13), and Biofilter Bags (SE-14) for situations where staking or trenching is not possible.
- Do not use fiber rolls on slopes subject to creep, slumping, or landslides.
- Improper installation of a fiber roll such as not being trenched in, not staked appropriately, or not sufficiently overlapping at the ends, may cause undercutting and increased erosion.
- Fiber rolls installed by the Type 1 method are not effective unless trenched in and staked. If not properly staked and trenched in, fiber rolls will not work as intended and could be transported by high flows.
- Fiber rolls installed by the Type 2 method are not effective unless staked. If not properly staked in, fiber rolls will not work as intended and could be transported by high flows.
- Not intended for use in concentrated flows.
- Not intended to contain stormwater. See Sediment Basin (SE-2) or Sediment Trap (SE-3) for stormwater containment BMPs.
- Difficult to move once saturated.
- Difficult to repair when a small section of the fiber roll is damaged. Replacement of the entire fiber roll or installation of an additional fiber roll adjacent to the damage is often required.
- Fiber rolls are susceptible to damage from wildlife.
- Fiber rolls have a limited sediment capture zone.
- Fiber rolls typically function for 12-24 months, depending upon local conditions, roll material, and installation method. For example, the Type 2 installation method may last longer than the Type 1 installation method because the fiber roll is not penetrated.

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- Fiber rolls that come manufactured containing polyacrylamide (PAM), a flocculating agent within the roll, are considered passive treatment technologies and are subject to additional requirements, see Passive Treatment (SE-15).

Implementation

Fiber Roll Materials

- Fiber rolls are to be prefabricated.
- Fiber rolls are made from weed-free rice straw, flax, curled wood fiber, or coir bound into a tight tubular roll by netting or wrap (see Limitations above regarding plastic netting).
- Typical fiber rolls vary in diameter from 6 in. to 20 in. Larger diameter rolls are available as well. The larger the roll diameter, the higher the sediment retention capacity.
- Typical fiber rolls lengths are 4, 10, 20 and 25 ft., although other lengths may be available.

Installation

- Locate fiber rolls on level contours spaced as follows:
  - Slope inclination between 20:1 and 4:1 -20 (H:V): Place fibers rolls at a maximum interval of 35 ft.
  - Slope inclination of 4:1 (H:V): Place fiber rolls at a maximum interval of 20 ft.
  - Slope inclination between 4:1 and 2:1 (H:V): Place fiber rolls at a maximum interval of 15 ft. (a closer spacing is more effective).
  - Slope inclination 2:1 (H:V) or greater: Place fiber rolls at a maximum interval of 10 ft. (a closer spacing is more effective).
- It is critical that fiber rolls are installed perpendicular to water flow and parallel to the slope contour.
- Prepare the slope before beginning installation.
- Dig small trenches across the slope on the contour. The trench depth is to be ¼ to 1/3 of the thickness of the roll, and the width is to be equal to the roll diameter, in order to provide area to backfill the trench.
- Use wood stakes with a nominal classification of 0.75 by 0.75 in. and minimum length of 24 in.
- For Type 1 installations:
  - Place in a trench that is from 2 to 4 inches deep.
  - Fasten with wood stakes every 4 feet along the length of the fiber roll.
  - Fasten the ends of the fiber roll by placing a stake 6 inches from the end of the roll.

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- Drive the stakes into the soil so the top of the stake is less than 2 inches above the top of the fiber roll.

- For Type 2 installations (Caltrans, 2024):
  - Trenching in the fiber rolls is optional.
  - J-hook the ends of the fiber roll up-slope to prevent runoff from going around the fiber roll.
  - Drive stakes along alternating sides of each fiber roll, spaced 2 ft. apart. Stakes are to alternate between upslope and downslope of the fiber roll.
  - Lace the rope tightly around the stakes and over the fiber roll. Knot the rope at each stake.
  - Tighten the fiber roll to the surface of the slope by driving the stakes further into the soil.
- If more than one fiber roll is placed in a row, the rolls should overlap, not abut at the ends. Stagger overlapping joints in adjacent rows by 5 to 10 feet.
- See typical fiber roll installation details at the end of this fact sheet.

Removal

- Fiber rolls can be left in place or be removed depending on the type of fiber roll and its application (temporary vs. permanent installation).
- For temporary installations, only remove fiber rolls when upgradient areas are stabilized per General Permit requirements, and/or pollutant sources are no longer present. Remove fiber rolls before vegetation becomes too mature so that the removal process does not disturb more soil and vegetation than is necessary.
- For permanent installations for final stabilization, fiber rolls encased with plastic netting or containing any plastic material are to be removed from the site. If a fiber roll is to be left in place as part of a final stabilization design, the fiber roll must be non-plastic, made of plant-based materials (e.g., burlap-wrapped, coconut jute netting, and any other plant-based netting), and fully biodegradable.
- Fiber rolls can be an effective component of a final stabilization system, if all components of the fiber rolls are plant-based, fully biodegradable, and the fiber rolls are coupled with fully biodegradable effective erosion control measures (hydroseeding, RECPs, etc.) properly applied/installed per manufacturer's specifications and/or per the current CASQA BMP Fact Sheets. Removal of fiber rolls that are used as part of a final stabilization system can result in greater disturbance; therefore, during the BMP planning phase, only specify fiber rolls wrapped in non-plastic fully biodegradable materials for areas where fiber rolls will be used on final slopes.

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Inspection and Maintenance

- BMPs are to be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that BMPs be inspected weekly at a minimum and prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Repair/replace split, torn, unraveling, or slumping fiber rolls as needed.
- Replace fiber rolls when they are disintegrated, flattened, and no longer effective.
- If construction activities or access to a work area are impaired by a fiber roll, move the fiber roll to avoid its damage or disintegration. Reinstall the fiber roll once active work is complete.
- If a fiber roll is used as a sediment capture device, or as an erosion control device to maintain sheet flows, periodically remove sediment that accumulates upgradient of the fiber roll to maintain BMP effectiveness. Remove sediment when sediment accumulation reaches one-third of the height of the fiber roll.
- If fiber rolls are used for erosion control, such as in a check dam, sediment removal may not be required as long as the system continues to control the grade. Sediment control BMPs will be implemented in conjunction with this type of application.
- Repair any undercutting, rills, and gullies promptly.

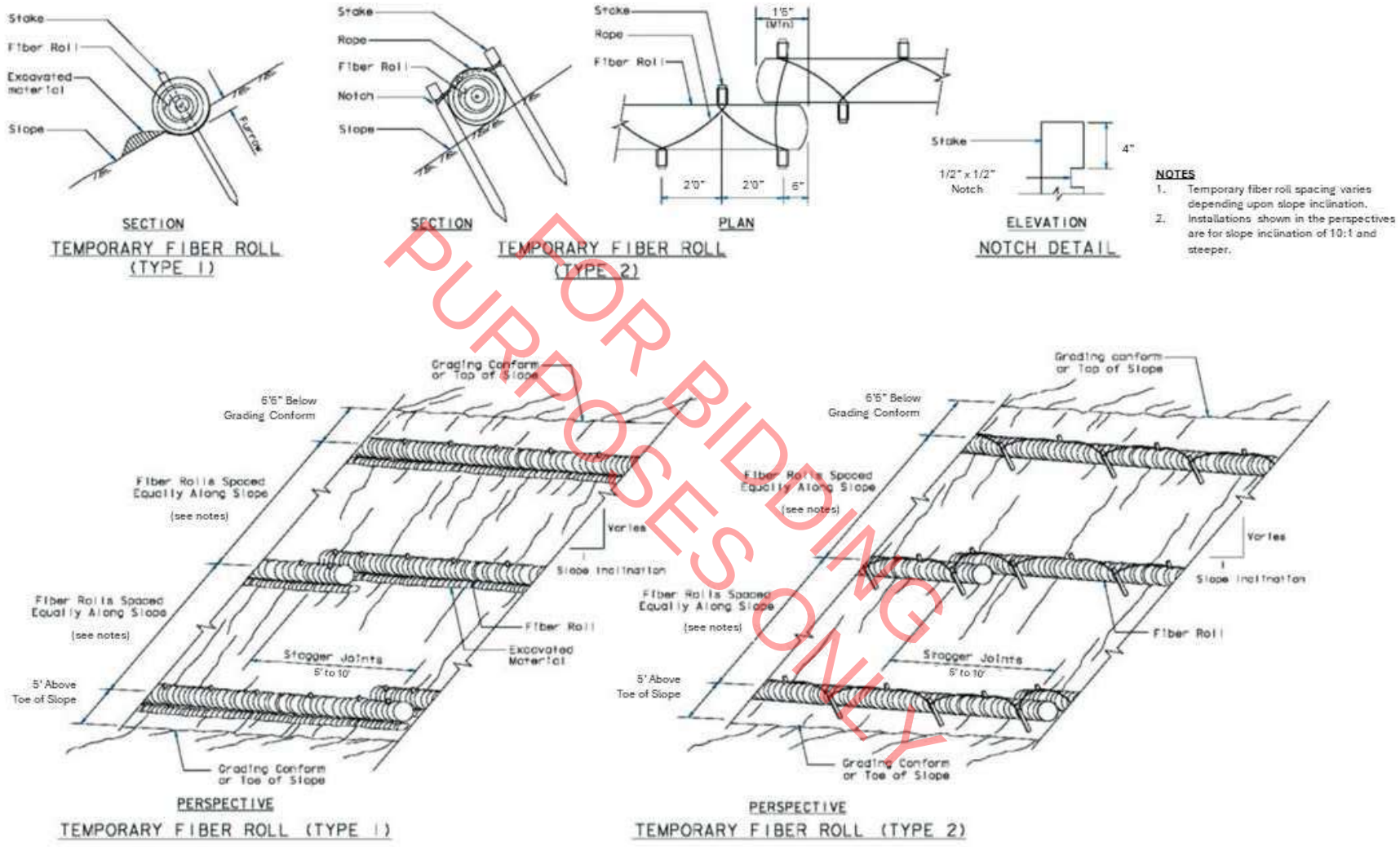
References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425-11.1, Section 4, Fiber Rolls SC-5, California Department of Transportation (Caltrans), March 2024.

Construction Stormwater Program website, State Water Resources Control Board, online at: https://www.waterboards.ca.gov/water_issues/programs/stormwater/construction.html

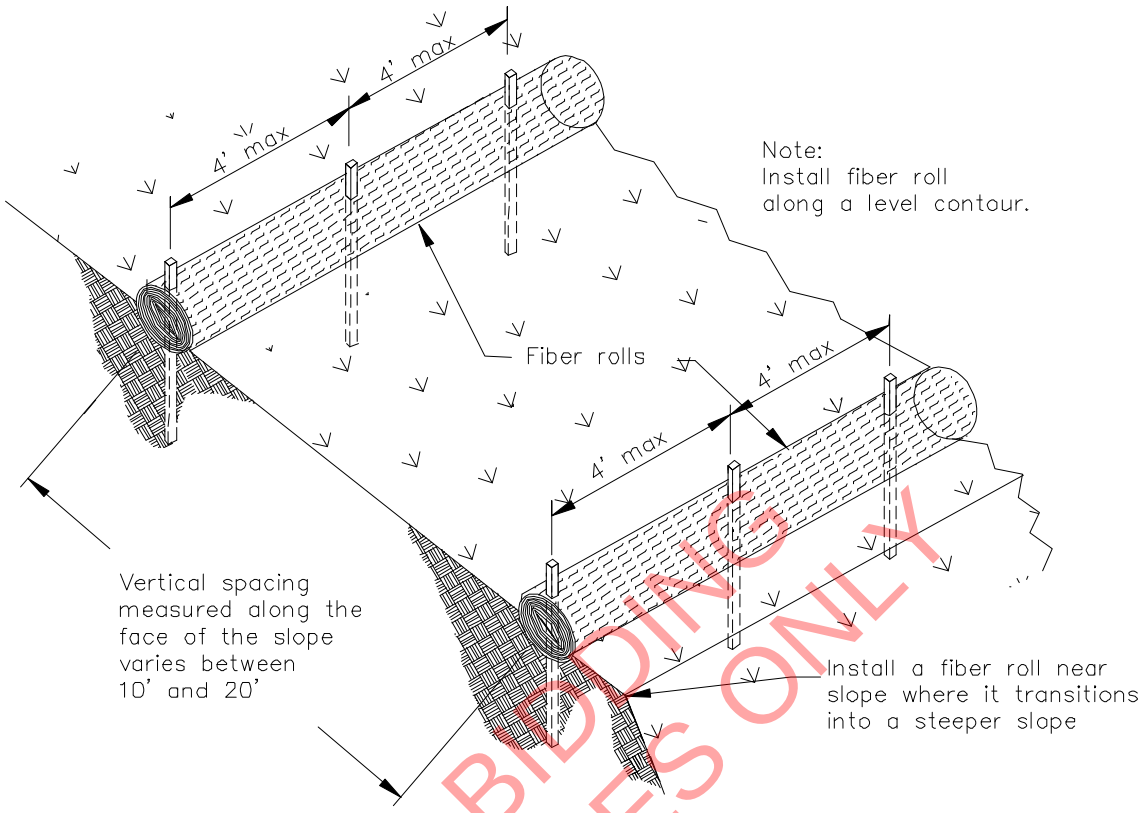
Order 2022-0057-DWQ, NPDES General Permit No. CAS000002: National Pollutant Discharge Elimination System (NDPES) General Permit for Stormwater Discharges Associated with Construction and Land Disturbance Activities (General Permit), California State Water Resources Control Board (State Water Board), September 2022.

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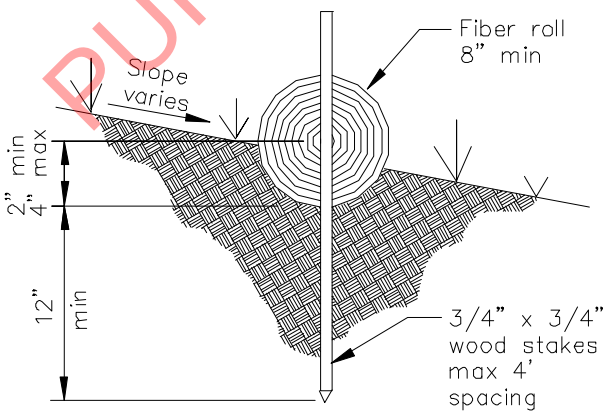
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Reference: Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425-11.1, Section 4, Fiber Rolls SC-5, California Department of Transportation (Caltrans), March 2024.

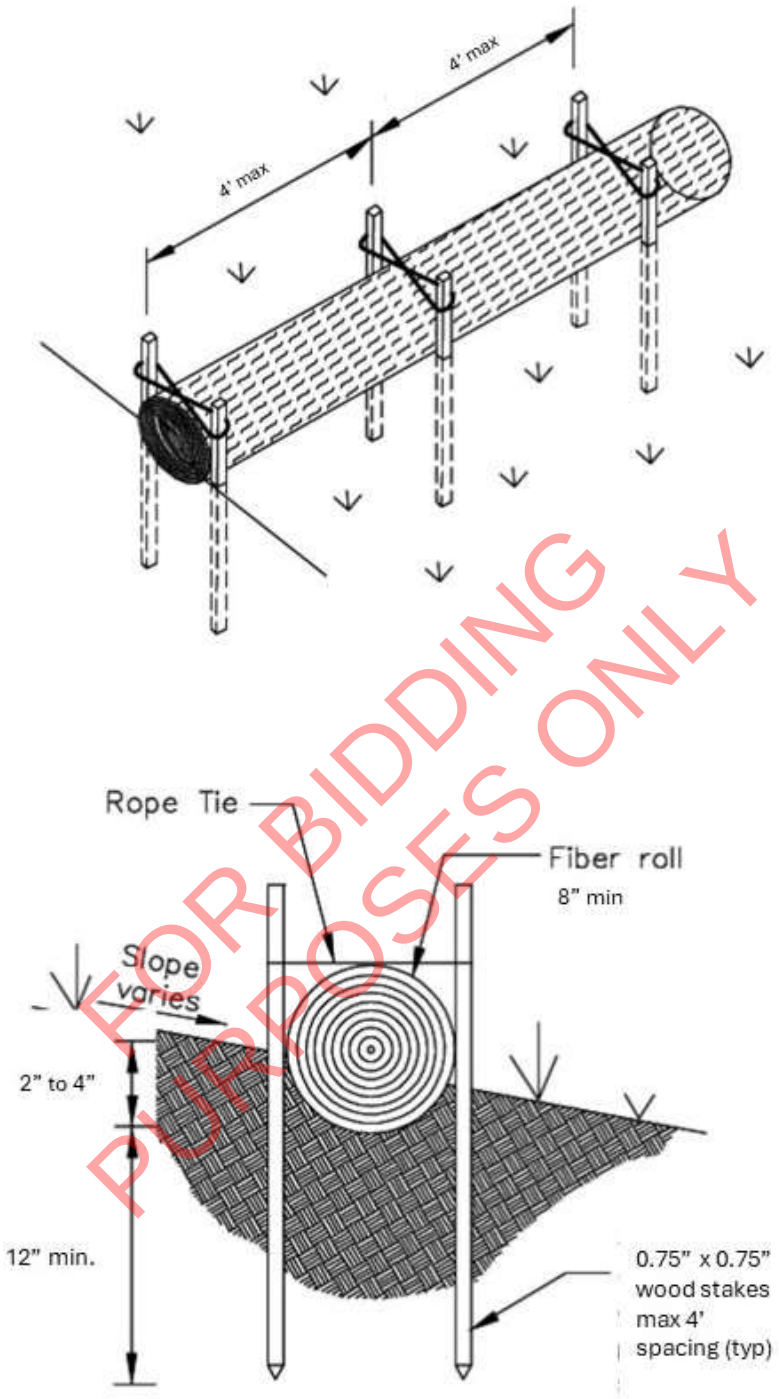


TYPICAL FIBER ROLL INSTALLATION
N.T.S.

FOR BIDDING PURPOSES ONLY



ENTRENCHMENT DETAIL
N.T.S.



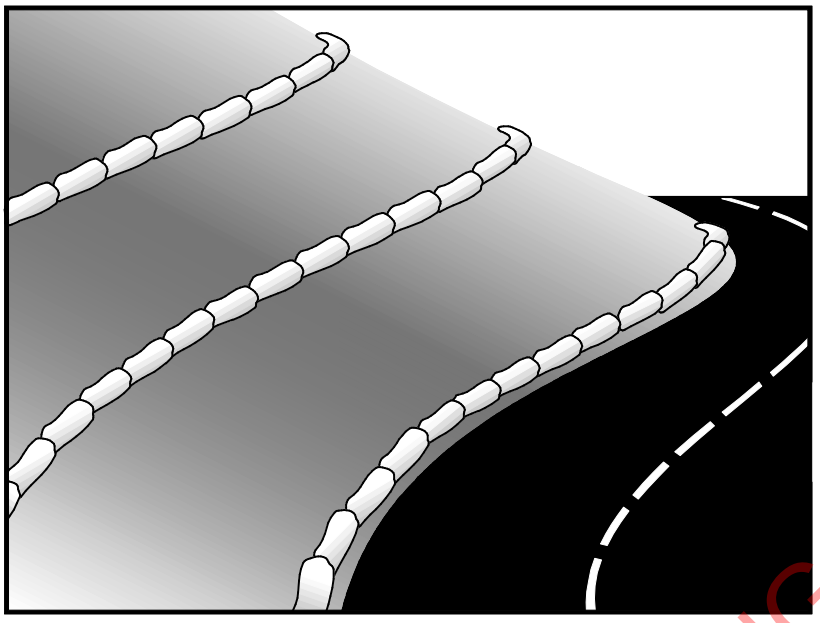
OPTIONAL ENTRENCHMENT DETAIL

N.T.S.

FOR BIDDING PURPOSES ONLY

Reference: Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425-11.1, Section 4, Fiber Rolls SC-5, California Department of Transportation (Caltrans), March 2024.

Gravel Bag Berm SE-6



Categories

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 Category**
☒ **Secondary Category**

Description and Purpose

A gravel bag berm is a series of gravel-filled bags placed on a level contour to intercept sheet flows. Gravel bags pond sheet flow runoff, allowing sediment to settle out, and release runoff slowly as sheet flow, preventing erosion.

Suitable Applications

Gravel bag berms may be suitable:

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes
  - As sediment traps at culvert/pipe outlets
  - Below other small cleared areas
  - Along the perimeter of a site
  - Down slope of exposed soil areas
  - Around temporary stockpiles and spoil areas
  - Parallel to a roadway to keep sediment off paved areas
  - Along streams and channels
- As a linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

SE-1 Silt Fence
SE-5 Fiber Roll
SE-8 Sandbag Barrier
SE-12 Temporary Silt Dike
SE-14 Biofilter Bags

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- At the top of slopes to divert runoff away from disturbed slopes.
- As chevrons (small check dams) across mildly sloped construction roads. For use check dam use in channels, see SE-4, Check Dams.

Limitations

- Gravel berms may be difficult to remove.
- Removal problems limit their usefulness in landscaped areas.
- Gravel bag berm may not be appropriate for drainage areas greater than 5 acres.
- Runoff will pond upstream of the berm, possibly causing flooding if sufficient space does not exist.
- Degraded gravel bags may rupture when removed, spilling contents.
- Installation can be labor intensive.
- Durability of gravel bags is somewhat limited, and bags may need to be replaced when installation is required for longer than 6 months.
- Easily damaged by construction equipment.
- When used to detain concentrated flows, maintenance requirements increase.

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Implementation

General

A gravel bag berm consists of a row of open graded gravel-filled bags placed on a level contour. When appropriately placed, a gravel bag berm intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. The open graded gravel in the bags is porous, which allows the ponded runoff to flow slowly through the bags, releasing the runoff as sheet flows. Gravel bag berms also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets, which erode rills, and ultimately gullies, into disturbed, sloped soils. Gravel bag berms are similar to sand bag barriers but are more porous. Generally, gravel bag berms should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate gravel bag berms on level contours.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Gravel bags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Gravel bags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

Slope inclination 2:1 (H:V) or greater: Gravel bags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the gravel bag barriers up slope to prevent runoff from going around the berm.
- Allow sufficient space up slope from the gravel bag berm to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, gravel bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the gravel bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- In Non-Traffic Areas:
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more-layer construction
  - Top width = 12 in. minimum for one- or two-layer construction
  - Side slopes = 2:1 (H:V) or flatter
- In Construction Traffic Areas:
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more-layer construction.
  - Top width = 12 in. minimum for one- or two-layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- Butt ends of bags tightly.
- On multiple row, or multiple layer construction, overlap butt joints of adjacent row and row beneath.
- Use a pyramid approach when stacking bags.

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Materials

- ***Bag Material:*** Bags should be woven polypropylene, polyethylene or polyamide fabric or burlap, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355.

- ***Bag Size:*** Each gravel-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal and may vary based on locally available materials.

- ***Fill Material:*** Fill material should be 0.5 to 1 in. Crushed rock, clean and free from clay, organic matter, and other deleterious material, or other suitable open graded, non-cohesive, porous gravel.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Gravel bags exposed to sunlight will need to be replaced every two to three months due to degrading of the bags.

- Reshape or replace gravel bags as needed.

- Repair washouts or other damage as needed.

- Sediment that accumulates in the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.

- Remove gravel bag berms when no longer needed and recycle gravel fill whenever possible and properly dispose of bag material. Remove sediment accumulation and clean, re-grade, and stabilize the area.

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References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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

Stormwater Pollution Plan Handbook, First Edition, State of California, Department of Transportation Division of New Technology, Materials and Research, October 1992.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

Street Sweeping and Vacuuming SE-7



Categories

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

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Description and Purpose

Street sweeping and vacuuming includes use of self-propelled and walk-behind equipment to remove sediment from streets and roadways and to clean paved surfaces in preparation for final paving. Sweeping and vacuuming prevents sediment from the project site from entering storm drains or receiving waters.

Suitable Applications

Sweeping and vacuuming are suitable anywhere sediment is tracked from the project site onto public or private paved streets and roads, typically at points of egress. Sweeping and vacuuming are also applicable during preparation of paved surfaces for final paving.

Limitations

- Sweeping and vacuuming may not be effective when sediment is wet or when tracked soil is caked (caked soil may need to be scraped loose).
- Sweeping may be less effective for fine particle soils (i.e., clay).

Implementation

- Controlling the number of points where vehicles can leave the site will allow sweeping and vacuuming efforts to be focused and perhaps save money.
- Inspect potential sediment tracking locations daily.

- Visible sediment tracking should be swept or vacuumed on a daily basis.
- Do not use kick brooms or sweeper attachments. These tend to spread the dirt rather than remove it.
- If not mixed with debris or trash, consider incorporating the removed sediment back into the project

Inspection and Maintenance

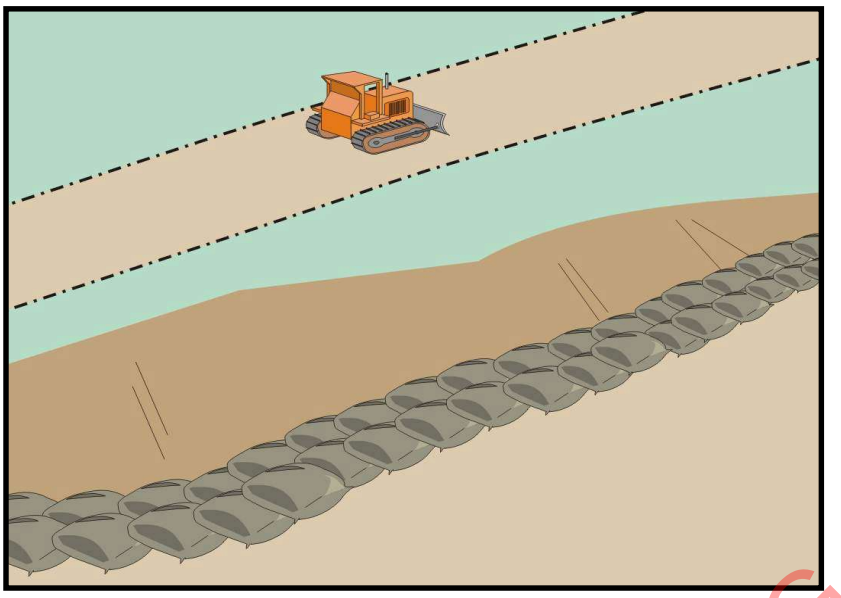
- Inspect BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- When actively in use, points of ingress and egress must be inspected daily.
- When tracked or spilled sediment is observed outside the construction limits, it must be removed at least daily. More frequent removal, even continuous removal, may be required in some jurisdictions.
- Be careful not to sweep up any unknown substance or any object that may be potentially hazardous.
- Adjust brooms frequently; maximize efficiency of sweeping operations.
- After sweeping is finished, properly dispose of sweeper wastes at an approved dumpsite.

References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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Sandbag Barrier SE-8



Categories

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 Category**
☒ **Secondary Category**

Description and Purpose

A sandbag barrier is a series of sand-filled bags placed on a level contour to intercept or to divert sheet flows. Sandbag barriers placed on a level contour pond sheet flow runoff, allowing sediment to settle out.

Suitable Applications

Sandbag barriers may be a suitable control measure for the applications described below. It is important to consider that sand bags are less porous than gravel bags and ponding or flooding can occur behind the barrier. Also, sand is easily transported by runoff if bags are damaged or ruptured. The SWPPP Preparer should select the location of a sandbag barrier with respect to the potential for flooding, damage, and the ability to maintain the BMP.

- As a linear sediment control measure:
  - Below the toe of slopes and erodible slopes.
  - As sediment traps at culvert/pipe outlets.
  - Below other small cleared areas.
  - Along the perimeter of a site.
  - Down slope of exposed soil areas.
  - Around temporary stockpiles and spoil areas.
  - Parallel to a roadway to keep sediment off paved areas.
  - Along streams and channels.

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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-12 Manufactured Linear Sediment Controls

SE-14 Biofilter Bags

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- As linear erosion control measure:
  - Along the face and at grade breaks of exposed and erodible slopes to shorten slope length and spread runoff as sheet flow.
  - At the top of slopes to divert runoff away from disturbed slopes.
  - As check dams across mildly sloped construction roads.

Limitations

- It is necessary to limit the drainage area upstream of the barrier to 5 acres.
- Sandbags are not intended to be used as filtration devices.
- Easily damaged by construction equipment.
- Degraded sandbags may rupture when removed, spilling sand.
- Installation can be labor intensive.
- Durability of sandbags is somewhat limited, and bags will need to be replaced when there are signs of damage or wear.
- Burlap should not be used for sandbags.

FOR BIDDING PURPOSES ONLY

Implementation

General

A sandbag barrier consists of a row of sand-filled bags placed on a level contour. When appropriately placed, a sandbag barrier intercepts and slows sheet flow runoff, causing temporary ponding. The temporary ponding allows sediment to settle. Sand-filled bags have limited porosity, which is further limited as the fine sand tends to quickly plug with sediment, limiting or completely blocking the rate of flow through the barrier. If a porous barrier is desired, consider SE-1, Silt Fence, SE-5, Fiber Rolls, SE-6, Gravel Bag Berms or SE-14, Biofilter Bags. Sandbag barriers also interrupt the slope length and thereby reduce erosion by reducing the tendency of sheet flows to concentrate into rivulets which erode rills, and ultimately gullies, into disturbed, sloped soils. Sandbag barriers are similar to gravel bag berms, but less porous. Generally, sandbag barriers should be used in conjunction with temporary soil stabilization controls up slope to provide effective erosion and sediment control.

Design and Layout

- Locate sandbag barriers on a level contour.
- When used for slope interruption, the following slope/sheet flow length combinations apply:
  - Slope inclination of 4:1 (H:V) or flatter: Sandbags should be placed at a maximum interval of 20 ft, with the first row near the slope toe.
  - Slope inclination between 4:1 and 2:1 (H:V): Sandbags should be placed at a maximum interval of 15 ft. (a closer spacing is more effective), with the first row near the slope toe.

  - Slope inclination 2:1 (H:V) or greater: Sandbags should be placed at a maximum interval of 10 ft. (a closer spacing is more effective), with the first row near the slope toe.

- Turn the ends of the sandbag barrier up slope to prevent runoff from going around the barrier.
- Allow sufficient space up slope from the barrier to allow ponding, and to provide room for sediment storage.
- For installation near the toe of the slope, sand bag barriers should be set back from the slope toe to facilitate cleaning. Where specific site conditions do not allow for a set-back, the sand bag barrier may be constructed on the toe of the slope. To prevent flows behind the barrier, bags can be placed perpendicular to a berm to serve as cross barriers.
- Drainage area should not exceed 5 acres.
- Butt ends of bags tightly.
- Overlap butt joints of row beneath with each successive row.
- Use a pyramid approach when stacking bags.
- In non-traffic areas
  - Height = 18 in. maximum
  - Top width = 24 in. minimum for three or more-layer construction
  - Side slope = 2:1 (H:V) or flatter
- In construction traffic areas
  - Height = 12 in. maximum
  - Top width = 24 in. minimum for three or more-layer construction.
  - Side slopes = 2:1 (H:V) or flatter.
- See typical sandbag barrier installation details at the end of this fact sheet.

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Materials

- ***Sandbag Material:*** Sandbag should be woven polypropylene, polyethylene or polyamide fabric, minimum unit weight of 4 ounces/yd^2, Mullen burst strength exceeding 300 lb/in^2 in conformance with the requirements in ASTM designation D3786, and ultraviolet stability exceeding 70% in conformance with the requirements in ASTM designation D4355. Use of burlap is not an acceptable substitute, as sand can more easily mobilize out of burlap.
- ***Sandbag Size:*** Each sand-filled bag should have a length of 18 in., width of 12 in., thickness of 3 in., and mass of approximately 33 lbs. Bag dimensions are nominal and may vary based on locally available materials.

- ***Fill Material:*** All sandbag fill material should be non-cohesive, Class 3 (Caltrans Standard Specification, Section 25) or similar permeable material free from clay and deleterious material, such as recycled concrete or asphalt.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Sandbags exposed to sunlight will need to be replaced every two to three months due to degradation of the bags.
- Reshape or replace sandbags as needed.
- Repair washouts or other damage as needed.
- Sediment that accumulates behind the BMP should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.
- Remove sandbags when no longer needed and recycle sand fill whenever possible and properly dispose of bag material. Remove sediment accumulation, and clean, re-grade, and stabilize the area.

References and Additional Resources

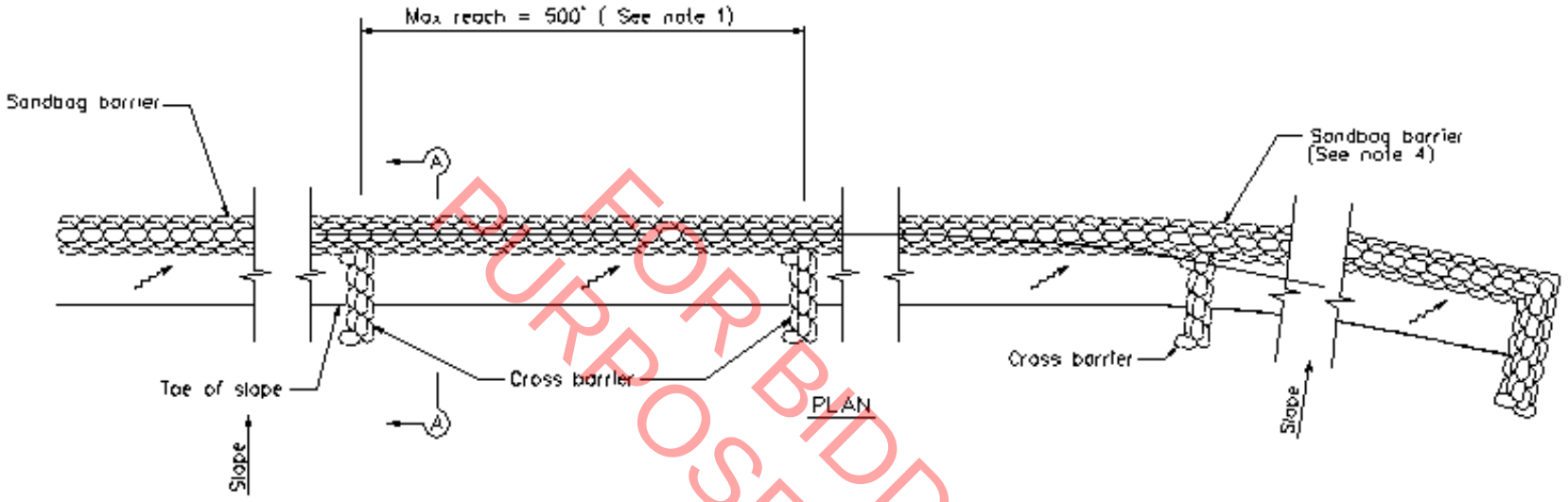
Construction Site Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

Standard Specifications for Construction of Local Streets and Roads, California Department of Transportation (Caltrans), July 2002.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

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Sandbag Barrier SE-8

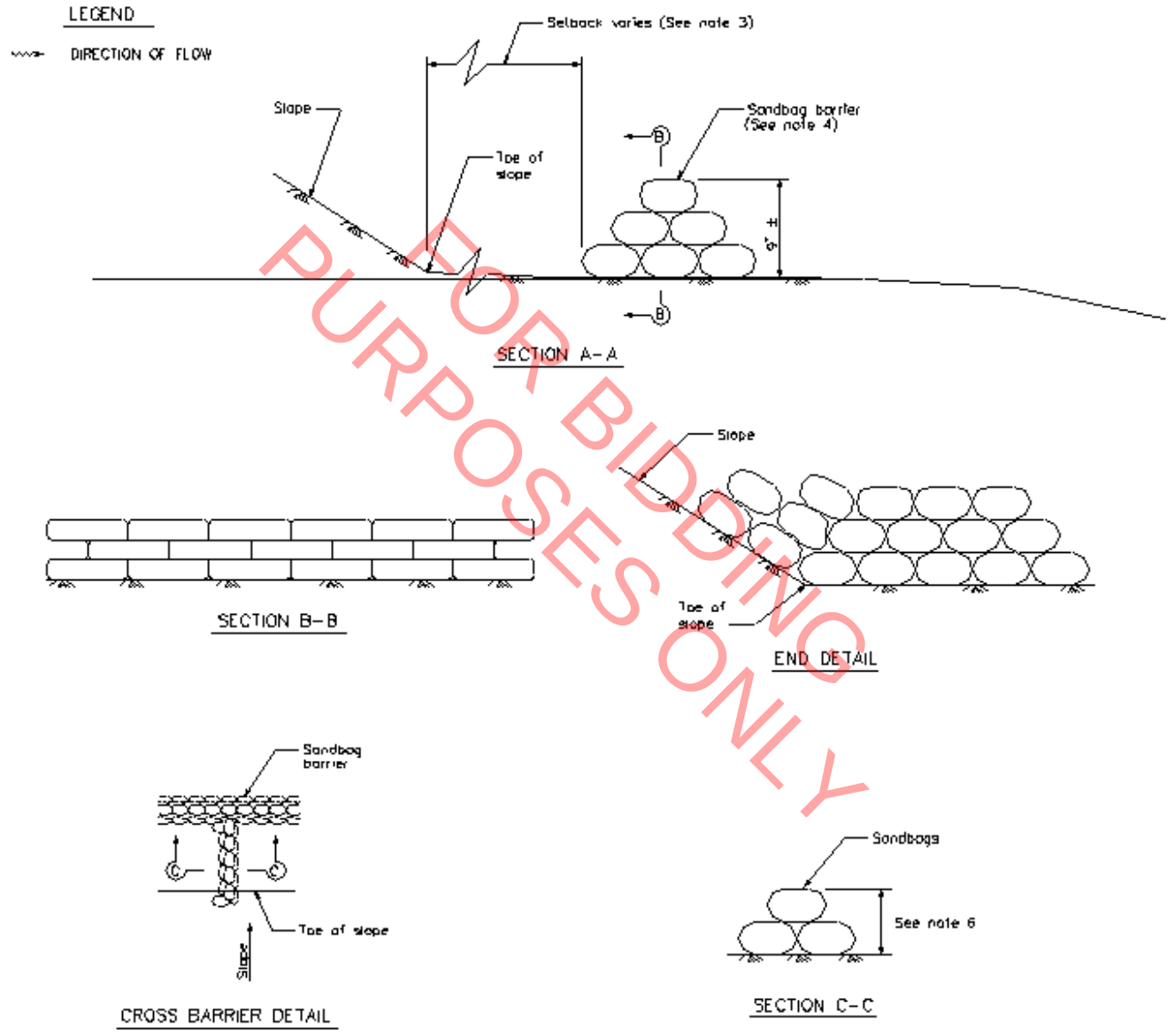


SANDBAG BARRIER

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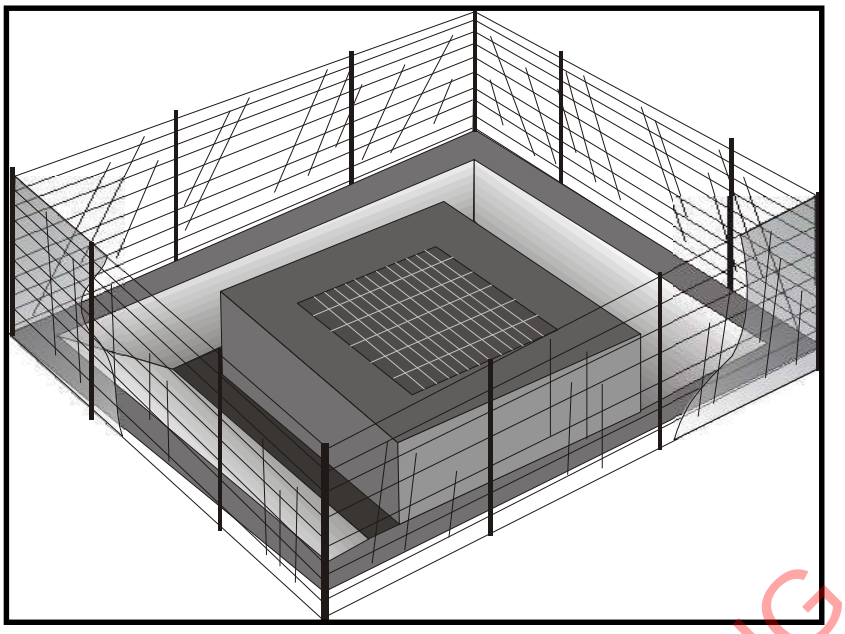
NOTES

1. Construct the length of each reach so that the change in base elevation along the reach does not exceed 1/2 the height of the linear barrier. In no case shall the reach length exceed 500'.
2. Place sandbags tightly
3. Dimension may vary to fit field condition.
4. Sandbag barrier shall be a minimum of 3 bags high.
5. The end of the barrier shall be turned up slope.
6. Cross barriers shall be a min of 1/2 and a max of 2/3 the height of the linear barrier.
7. Sandbag rows and layers shall be staggered to eliminate gaps.



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Storm Drain Inlet Protection SE-10



Categories

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 Category**

☒ **Secondary Category**

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-14 Biofilter Bags

SE-13 Compost Socks and Berms

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Description and Purpose

Storm drain inlet protection consists of a sediment filter or an impounding area in, 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. Temporary geotextile storm drain inserts attach underneath storm drain grates to capture and filter storm water.

Suitable Applications

- Every storm drain inlet receiving runoff from unstabilized or otherwise active work areas should be protected. Inlet protection should be used in conjunction with other erosion and sediment controls to prevent sediment-laden stormwater and non-stormwater discharges from entering the storm drain system.

Limitations

- Drainage area should not exceed 1 acre.
- In general straw bales should not be used as inlet protection.
- Requires an adequate area for water to pond without encroaching into portions of the roadway subject to traffic.
- Sediment removal may be inadequate to prevent sediment discharges in high flow conditions or if runoff is heavily sediment laden. If high flow conditions are expected, use

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other onsite sediment trapping techniques in conjunction with inlet protection.

- Frequent maintenance is required.
- Limit drainage area to 1 acre maximum. 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

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 and/or used in conjunction with other drainage control, erosion control, and sediment control BMPs to protect the site. Different types of inlet protection are appropriate for different applications depending on site conditions and the type of inlet. Alternative methods are available in addition to the methods described/shown herein such as prefabricated inlet insert devices, or gutter protection devices.

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.

- The key to successful and safe use of storm drain inlet protection devices is to know where runoff that is directed toward the inlet to be protected will pond or be diverted as a result of installing the protection device.
  - 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.
- Seven types of inlet protection are presented below. However, it is recognized that other effective methods and proprietary devices exist and may be selected.

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- Silt 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.

- Temporary Geotextile Storm drain Inserts: Different products provide different features. Refer to manufacturer details for targeted pollutants and additional features.

- Biofilter Bag Barrier: Used to create a small retention area upstream of inlets and can be located on pavement or soil. Biofilter bags slowly filter runoff allowing sediment to settle out. Appropriate for flows under 0.5 cfs.

- Compost Socks: Allow filtered run-off to pass through the compost while retaining sediment and potentially other pollutants (SE-13). Appropriate for flows under 1.0 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.

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Installation

- ***DI Protection Type 1 - Silt Fence -*** Similar to constructing a silt fence; see BMP SE-1, Silt Fence. Do not place fabric underneath the inlet grate since the collected sediment may fall into the drain inlet when the fabric is removed or replaced and water flow through the grate will be blocked resulting in flooding. See typical Type 1 installation details at the end of this fact sheet.

  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 should 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*** - 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. See typical Type 2 installation details at the end of this fact sheet.

- ***DI Protection Type 3 - Gravel bag*** - 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. See typical Type 3 installation details at the end of this fact sheet.

1. Construct on gently sloping street.

2. Leave room upstream of barrier for water to pond and sediment to settle.

3. Place several layers of gravel bags – overlapping the bags and packing them tightly together.

4. 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*** - Block and gravel filters are suitable for curb inlets commonly used in residential, commercial, and industrial construction. See typical Type 4 installation details at the end of this fact sheet.

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 woven geotextile 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.

- ***DI Protection Type 5 – Temporary Geotextile Insert (proprietary)*** – Many types of temporary inserts are available. Most inserts fit underneath the grate of a drop inlet or inside of a curb inlet and are fastened to the outside of the grate or curb. These inserts are

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removable, and many can be cleaned and reused. Installation of these inserts differs between manufacturers. Please refer to manufacturer instruction for installation of proprietary devices.

- ***DI Protection Type 6 - Biofilter bags*** – Biofilter bags may be used as a substitute for gravel bags in low-flow situations. Biofilter bags should conform to specifications detailed in SE-14, Biofilter bags.

    1. Construct in a gently sloping area.
    2. Biofilter bags should be placed around inlets to intercept runoff flows.
    3. All bag joints should overlap by 6 in.
    4. Leave room upstream for water to pond and for sediment to settle out.
    5. Stake bags to the ground as described in the following detail. Stakes may be omitted if bags are placed on a paved surface.

- ***DI Protection Type 7 – Compost Socks*** – A compost sock can be assembled on site by filling a mesh sock (e.g., with a pneumatic blower). Compost socks do not require special trenching compared to other sediment control methods (e.g., silt fence). Compost socks should conform to specification detailed in SE-13, Compost Socks and Berms.

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Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Silt 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. At a minimum, remove the sediment behind the fabric fence when accumulation reaches one-third the height of the fence or barrier height.

- Gravel Filters. If the gravel becomes clogged with sediment, it should 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 should be periodically removed in order to maintain BMP effectiveness. Sediment should be removed when the sediment accumulation reaches one-third of the barrier height.

- Inspect and maintain temporary geotextile insert devices according to manufacturer's specifications.

- 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 should be free of sediment and debris at the time of final inspection.

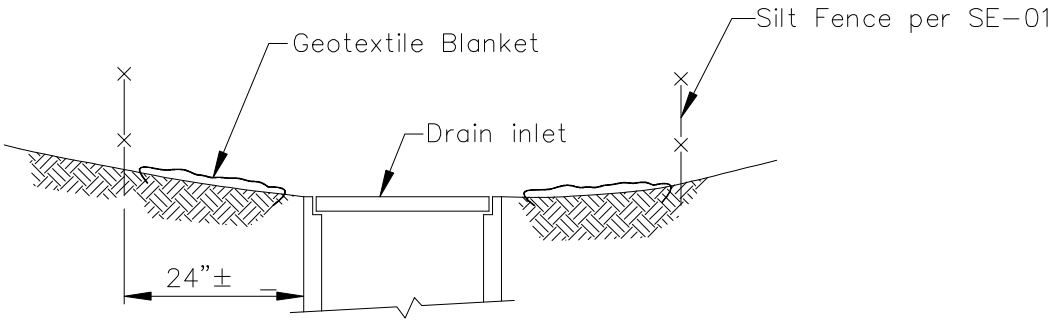
References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

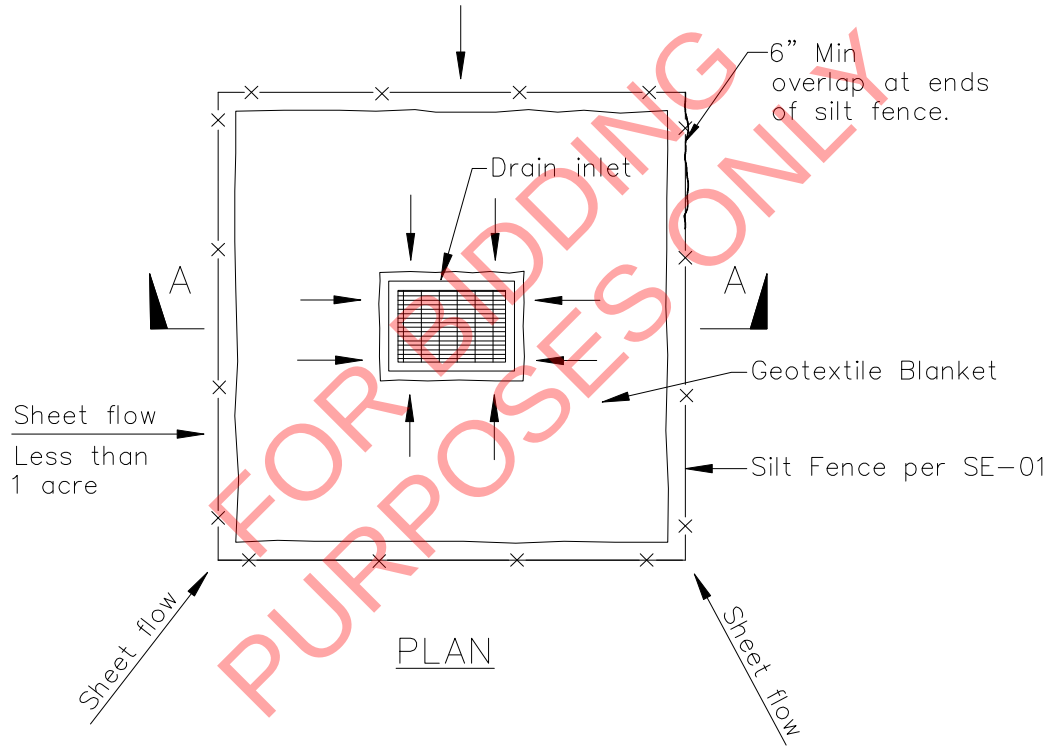
Stormwater Management Manual for The Puget Sound Basin, Washington State Department of Ecology, Public Review Draft, 1991.

Erosion and Sediment Control Manual, Oregon Department of Environmental Quality, February 2005.

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SECTION A–A



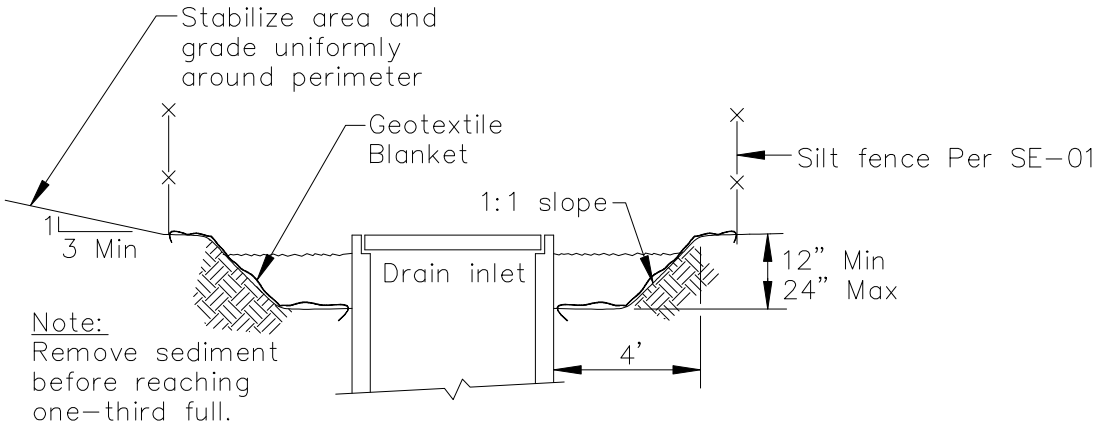
PLAN

DI PROTECTION TYPE 1
NOT TO SCALE

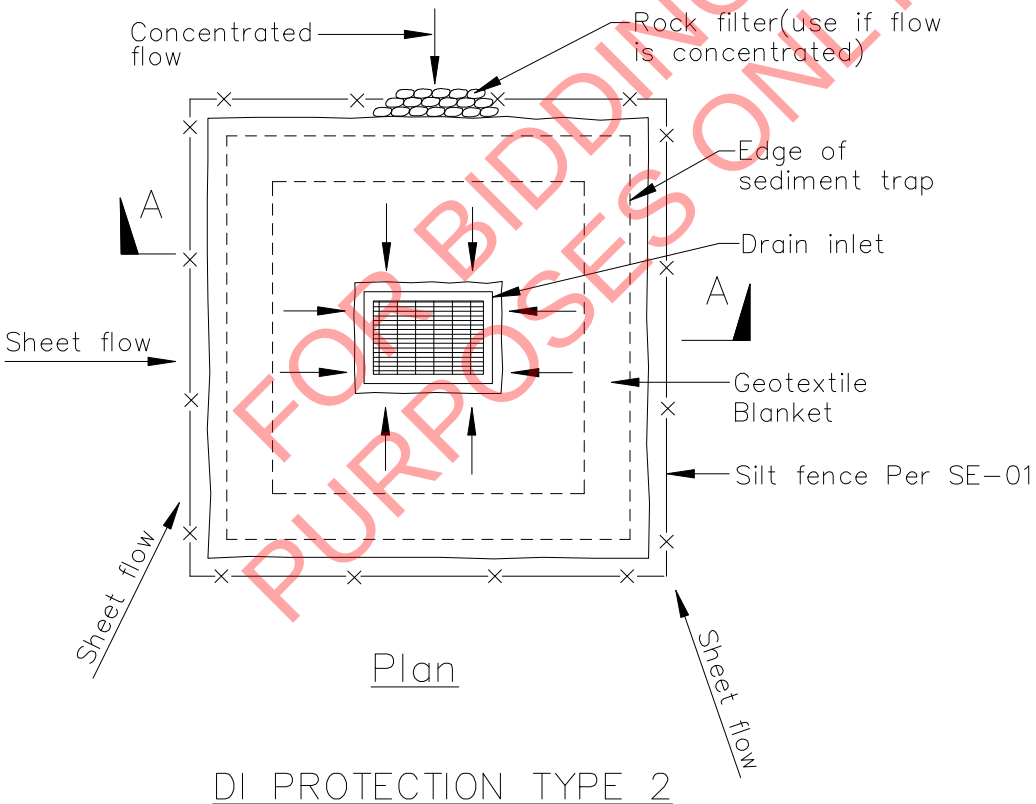
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NOTES:

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.



Section A–A

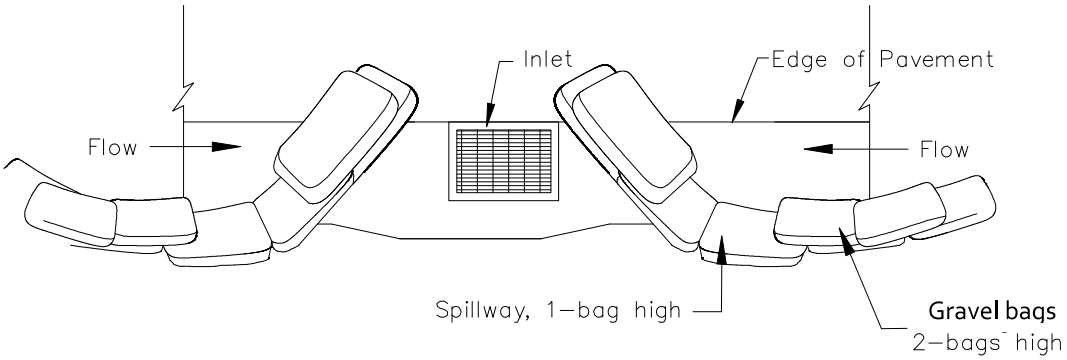


Plan

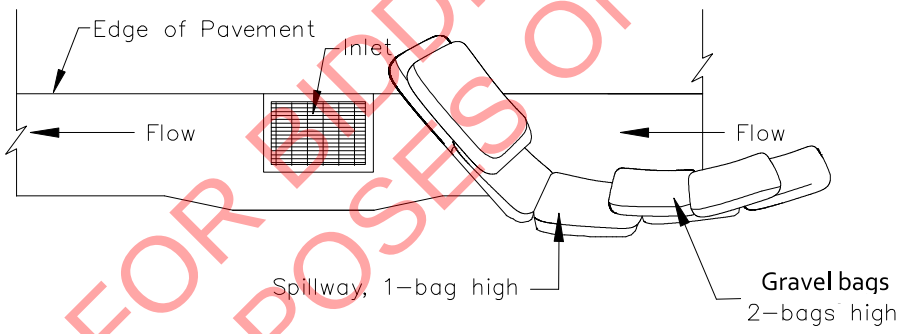
DI PROTECTION TYPE 2
NOT TO SCALE

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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



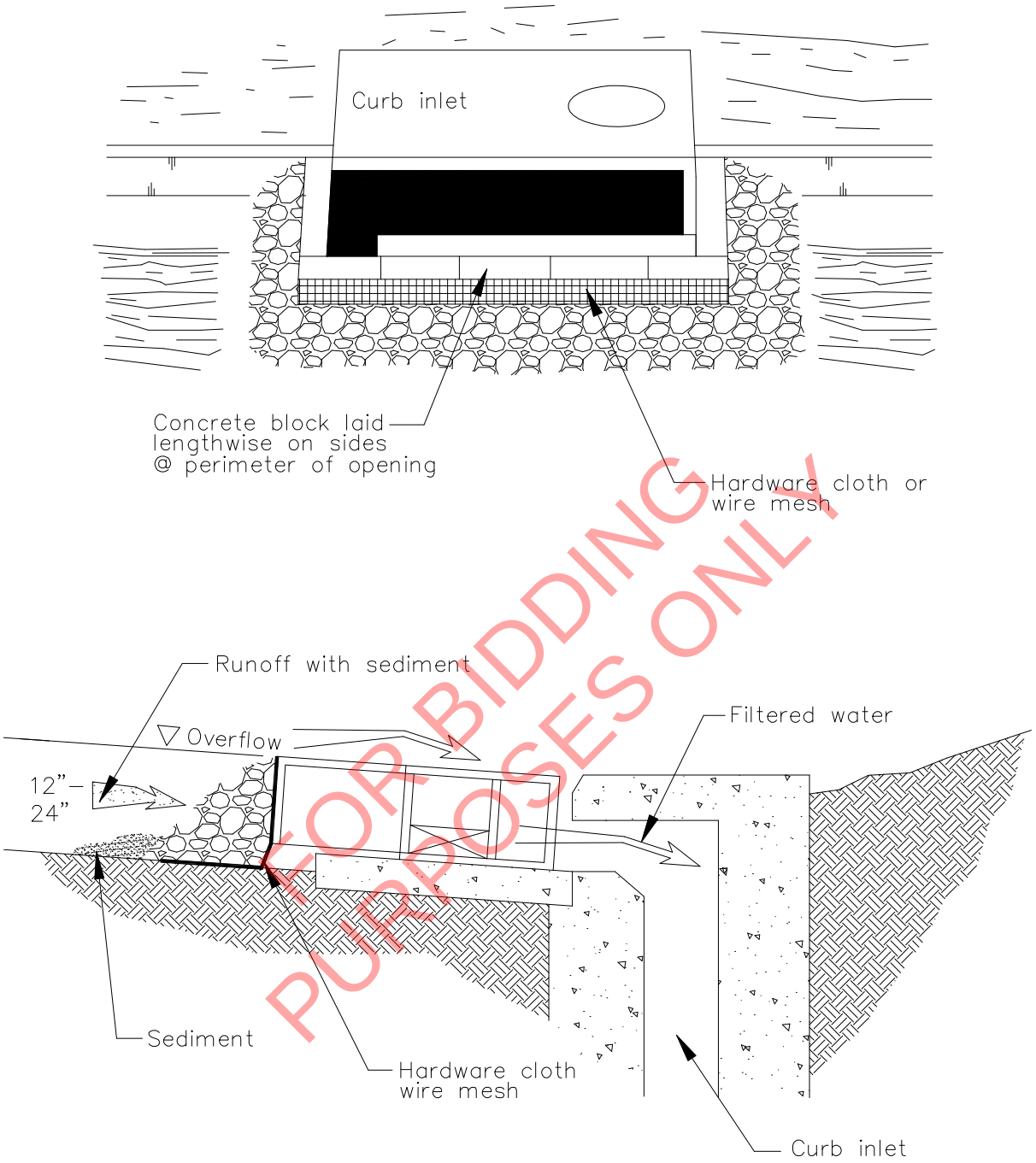
TYPICAL PROTECTION FOR INLET ON GRADE

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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.
6. Protection can be effective even if it is not immediately adjacent to the inlet provided that the inlet is protected from potential sources of pollution.

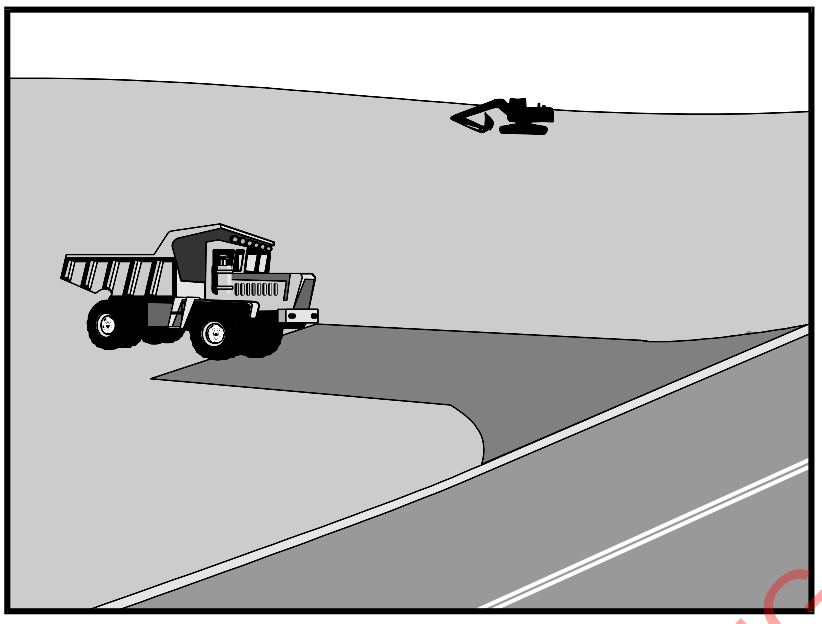
DI PROTECTION TYPE 3
NOT TO SCALE



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DI PROTECTION – TYPE 4
NOT TO SCALE

Stabilized Construction Entrance/Exit TC-1



Categories

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

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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.

Stabilized Construction Entrance/Exit TC-1

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.

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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 or maximum site will allow, and 10 ft minimum width or to accommodate traffic.
- 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 BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- 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

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References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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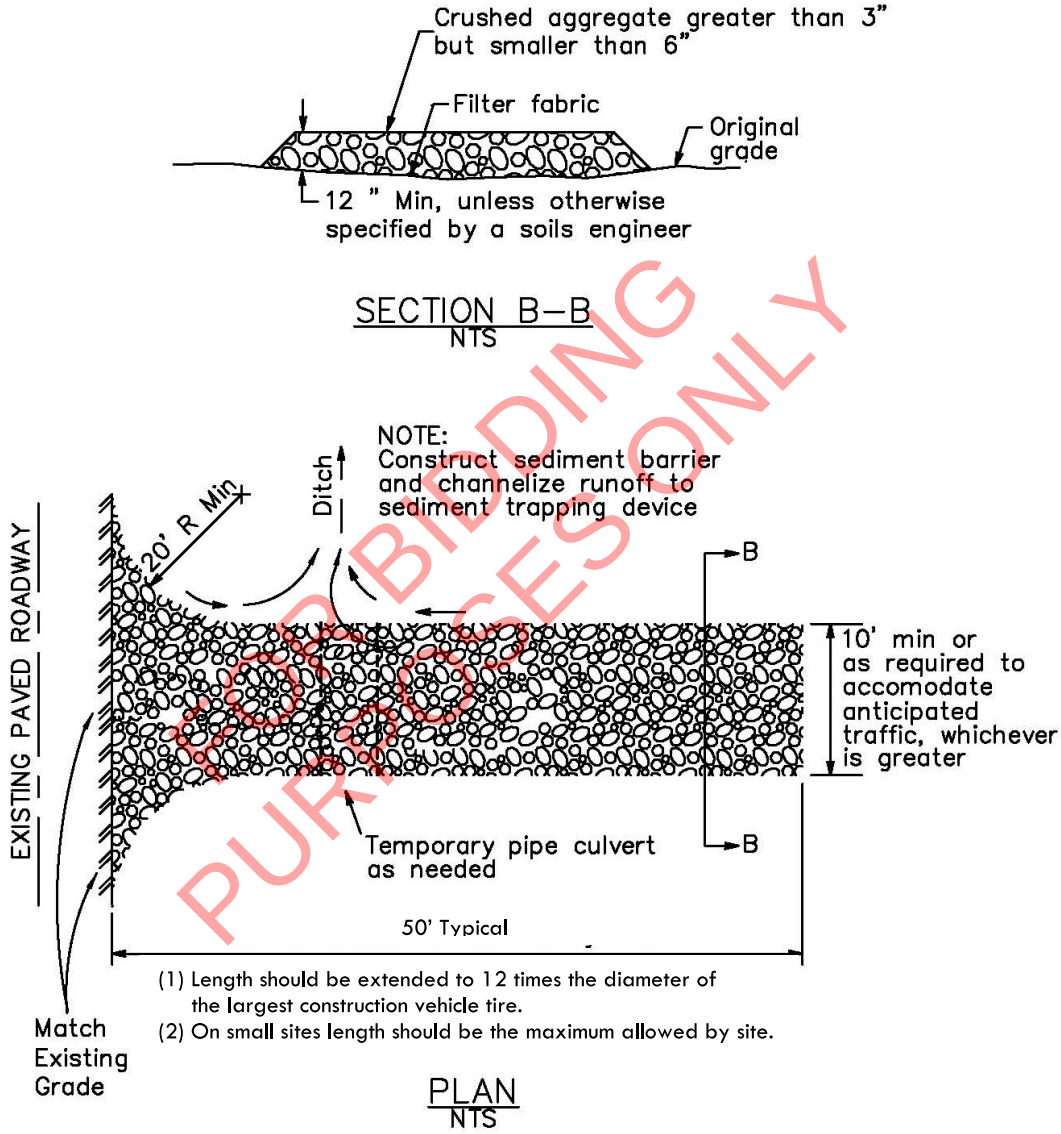
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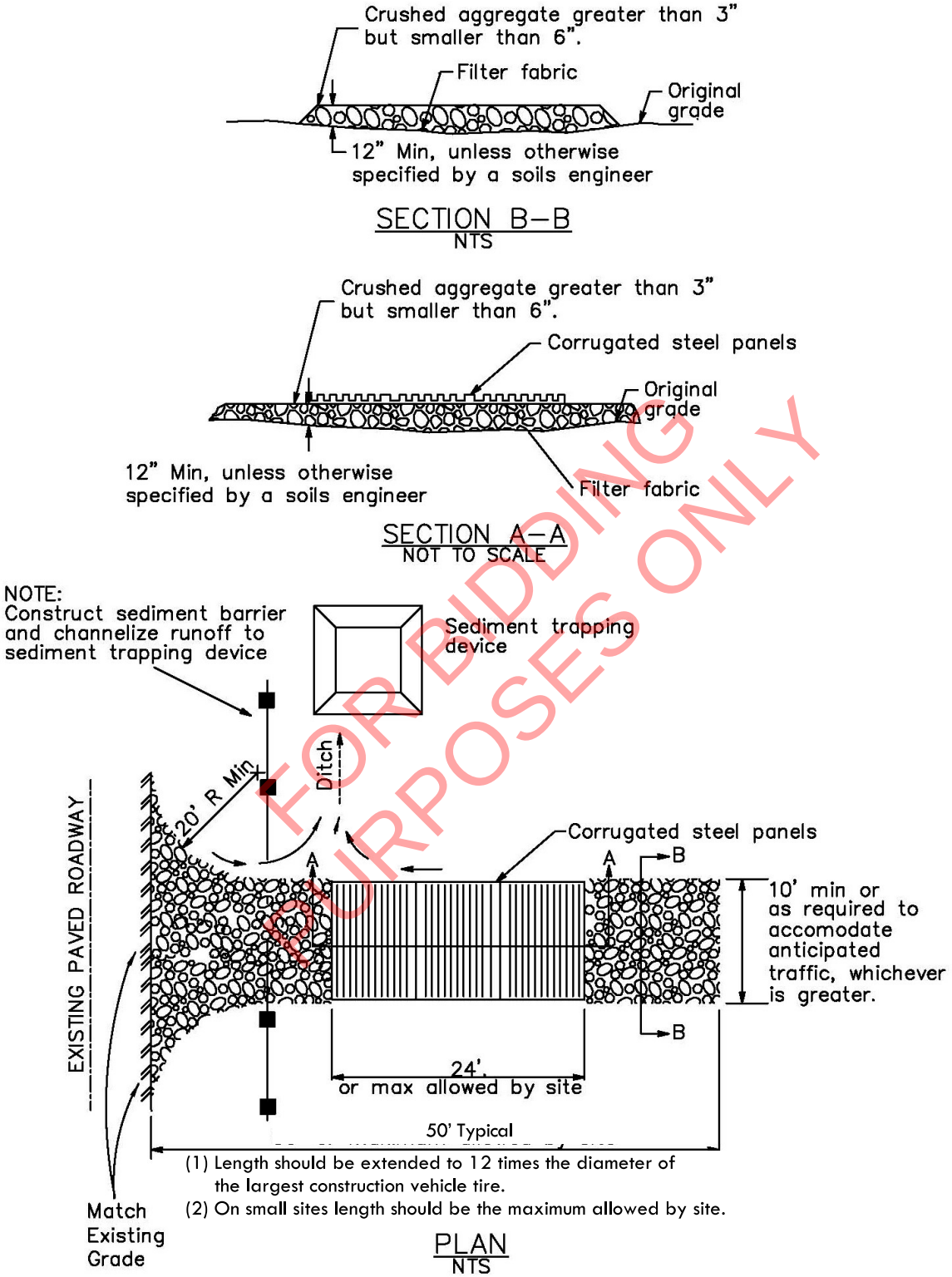
FOR BIDDING PURPOSES ONLY

Stabilized Construction Entrance/Exit TC-1



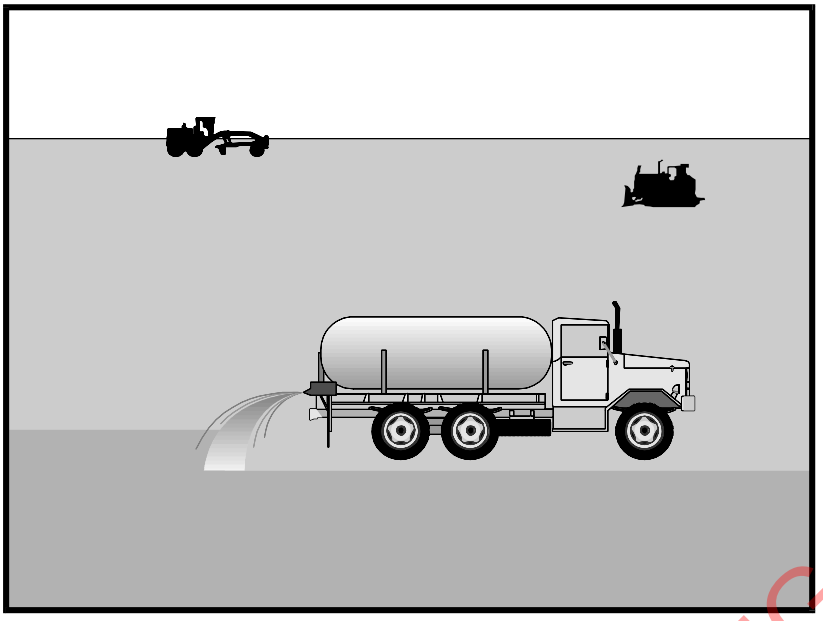
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Stabilized Construction Entrance/Exit TC-1



FOR BIDDING PURPOSES ONLY

Wind Erosion Control WE-1



Categories

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 Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

EC-5 Soil Binders

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Description and Purpose

Wind erosion or dust control consists of applying water or other chemical dust suppressants as necessary to prevent or alleviate dust nuisance generated by construction activities. Covering small stockpiles or areas is an alternative to applying water or other dust palliatives.

California's Mediterranean climate, with a short "wet" season and a typically long, hot "dry" season, allows the soils to thoroughly dry out. During the dry season, construction activities are at their peak, and disturbed and exposed areas are increasingly subject to wind erosion, sediment tracking, and dust generated by construction equipment. Site conditions and climate can make dust control more of an erosion problem than water-based erosion. Additionally, many local agencies, including Air Quality Management Districts, require dust control and/or dust control permits in order to comply with local nuisance laws, opacity laws (visibility impairment) and the requirements of the Clean Air Act. Wind erosion control is required to be implemented at all construction sites greater than 1 acre by the General Permit.

Suitable Applications

Most BMPs that provide protection against water-based erosion will also protect against wind-based erosion and dust control requirements required by other agencies will generally meet wind erosion control requirements for water quality protection. Wind erosion control BMPs are suitable during the following construction activities:

- Construction vehicle traffic on unpaved roads
- Drilling and blasting activities
- Soils and debris storage piles
- Batch drop from front-end loaders
- Areas with unstabilized soil
- Final grading/site stabilization

Limitations

- Watering prevents dust only for a short period (generally less than a few hours) and should be applied daily (or more often) to be effective.
- Over watering may cause erosion and track-out.
- Oil or oil-treated subgrade should not be used for dust control because the oil may migrate into drainageways and/or seep into the soil.
- Chemical dust suppression agents may have potential environmental impacts. Selected chemical dust control agents should be environmentally benign.
- Effectiveness of controls depends on soil, temperature, humidity, wind velocity and traffic.
- Chemical dust suppression agents should not be used within 100 feet of wetlands or water bodies.
- Chemically treated subgrades may make the soil water repellant, interfering with long-term infiltration and the vegetation/re-vegetation of the site. Some chemical dust suppressants may be subject to freezing and may contain solvents and should be handled properly.
- In compacted areas, watering and other liquid dust control measures may wash sediment or other constituents into the drainage system.
- If the soil surface has minimal natural moisture, the affected area may need to be pre-wetted so that chemical dust control agents can uniformly penetrate the soil surface.

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Implementation

Dust Control Practices

Dust control BMPs generally stabilize exposed surfaces and minimize activities that suspend or track dust particles. The following table presents dust control practices that can be applied to varying site conditions that could potentially cause dust. For heavily traveled and disturbed areas, wet suppression (watering), chemical dust suppression, gravel asphalt surfacing, temporary gravel construction entrances, equipment wash-out areas, and haul truck covers can be employed as dust control applications. Permanent or temporary vegetation and mulching can be employed for areas of occasional or no construction traffic. Preventive measures include

minimizing surface areas to be disturbed, limiting onsite vehicle traffic to 15 mph or less, and controlling the number and activity of vehicles on a site at any given time.

Chemical dust suppressants include: mulch and fiber based dust palliatives (e.g. paper mulch with gypsum binder), salts and brines (e.g. calcium chloride, magnesium chloride), non-petroleum based organics (e.g. vegetable oil, lignosulfonate), petroleum based organics (e.g. asphalt emulsion, dust oils, petroleum resins), synthetic polymers (e.g. polyvinyl acetate, vinyl, acrylic), clay additives (e.g. bentonite, montmorillonite) and electrochemical products (e.g. enzymes, ionic products).

Site Condition	Dust Control Practices							
	Permanent Vegetation	Mulching	Wet Suppression (Watering)	Chemical Dust Suppression	Gravel or Asphalt	Temporary Gravel Construction Entrances/Equipment Wash Down	Synthetic Covers	Minimize Extent of Disturbed Area
Disturbed Areas not Subject to Traffic	X	X	X	X	X			X
Disturbed Areas Subject to Traffic			X	X	X	X		X
Material Stockpiles		X	X	X			X	X
Demolition			X			X	X	
Clearing/ Excavation			X	X				X
Truck Traffic on Unpaved Roads			X	X	X	X	X	
Tracking					X	X		

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Additional preventive measures include:

- Schedule construction activities to minimize exposed area (see EC-1, Scheduling).
- Quickly treat exposed soils using water, mulching, chemical dust suppressants, or stone/gravel layering.
- Identify and stabilize key access points prior to commencement of construction.
- Minimize the impact of dust by anticipating the direction of prevailing winds.
- Restrict construction traffic to stabilized roadways within the project site, as practicable.
- Water should be applied by means of pressure-type distributors or pipelines equipped with a spray system or hoses and nozzles that will ensure even distribution.
- All distribution equipment should be equipped with a positive means of shutoff.
- Unless water is applied by means of pipelines, at least one mobile unit should be available at all times to apply water or dust palliative to the project.
- If reclaimed waste water is used, the sources and discharge must meet California Department of Health Services water reclamation criteria and the Regional Water Quality

Control Board (RWQCB) requirements. Non-potable water should not be conveyed in tanks or drain pipes that will be used to convey potable water and there should be no connection between potable and non-potable supplies. Non-potable tanks, pipes, and other conveyances should be marked, "NON-POTABLE WATER - DO NOT DRINK."

- Pave or chemically stabilize access points where unpaved traffic surfaces adjoin paved roads.
- Provide covers for haul trucks transporting materials that contribute to dust.
- Provide for rapid clean up of sediments deposited on paved roads. Furnish stabilized construction road entrances and wheel wash areas.
- Stabilize inactive areas of construction sites using temporary vegetation or chemical stabilization methods.

For chemical stabilization, there are many products available for chemically stabilizing gravel roadways and stockpiles. If chemical stabilization is used, the chemicals should not create any adverse effects on stormwater, plant life, or groundwater and should meet all applicable regulatory requirements.

FOR BIDDING PURPOSES ONLY

Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Check areas protected to ensure coverage.
- Most water-based dust control measures require frequent application, often daily or even multiple times per day. Obtain vendor or independent information on longevity of chemical dust suppressants.

References and Additional Resources

Best Management Practices and Erosion Control Manual for Construction Sites, Flood Control District of Maricopa County, Arizona, September 1992.

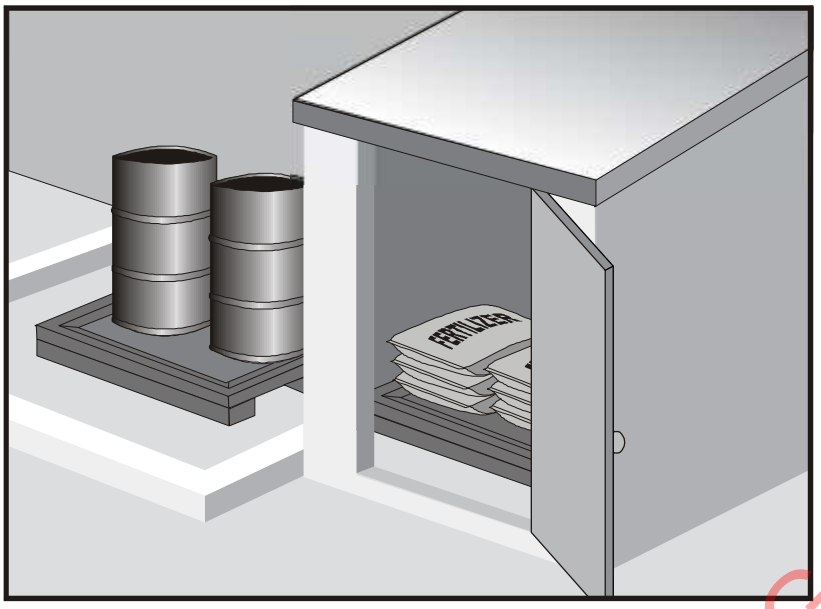
California Air Pollution Control Laws, California Air Resources Board, updated annually.

Construction Manual, Chapter 4, Section 10, "Dust Control"; Section 17, "Watering"; and Section 18, "Dust Palliative", California Department of Transportation (Caltrans), July 2001.

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

Prospects for Attaining the State Ambient Air Quality Standards for Suspended Particulate Matter (PM10), Visibility Reducing Particles, Sulfates, Lead, and Hydrogen Sulfide, California Air Resources Board, April 1991.

Material Delivery and Storage WM-1



Categories

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 Category**

☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Prevent, reduce, or eliminate the discharge of pollutants from material delivery and storage to the stormwater system or watercourses by minimizing the storage of hazardous materials onsite, storing materials in watertight containers and/or a completely enclosed designated area, installing secondary containment, conducting regular inspections, and training employees and subcontractors.

This best management practice covers only material delivery and storage. For other information on materials, see WM-2, Material Use, or WM-4, Spill Prevention and Control. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

These procedures are suitable for use at all construction sites with delivery and storage of the following materials:

- Soil stabilizers and binders
- Pesticides and herbicides
- Fertilizers
- Detergents
- Plaster
- Petroleum products such as fuel, oil, and grease

- Asphalt and concrete components
- Hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Concrete compounds
- Other materials that may be detrimental if released to the environment

Limitations

- Space limitation may preclude indoor storage.
- Storage sheds often must meet building and fire code requirements.

Implementation

The following steps should be taken to minimize risk:

- Chemicals must be stored in water tight containers with appropriate secondary containment or in a storage shed.
- When a material storage area is located on bare soil, the area should be lined and bermed.
- Use containment pallets or other practical and available solutions, such as storing materials within newly constructed buildings or garages, to meet material storage requirements.
- Stack erodible landscape material on pallets and cover when not in use.
- Contain all fertilizers and other landscape materials when not in use.
- Temporary storage areas should be located away from vehicular traffic.
- Material Safety Data Sheets (MSDS) should be available on-site for all materials stored that have the potential to effect water quality.
- Construction site areas should be designated for material delivery and storage.
- Material delivery and storage areas should be located away from waterways, if possible.
  - Avoid transport near drainage paths or waterways.
  - Surround with earth berms or other appropriate containment BMP. See EC-9, Earth Dikes and Drainage Swales.
  - Place in an area that will be paved.
- Storage of reactive, ignitable, or flammable liquids must comply with the fire codes of your area. Contact the local Fire Marshal to review site materials, quantities, and proposed storage area to determine specific requirements. See the Flammable and Combustible Liquid Code, NFPA30.
- An up to date inventory of materials delivered and stored onsite should be kept.

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- Hazardous materials storage onsite should be minimized.
- Hazardous materials should be handled as infrequently as possible.
- Keep ample spill cleanup supplies appropriate for the materials being stored. Ensure that cleanup supplies are in a conspicuous, labeled area.
- Employees and subcontractors should be trained on the proper material delivery and storage practices.
- Employees trained in emergency spill cleanup procedures must be present when dangerous materials or liquid chemicals are unloaded.
- If significant residual materials remain on the ground after construction is complete, properly remove and dispose of materials and any contaminated soil. See WM-7, Contaminated Soil Management. If the area is to be paved, pave as soon as materials are removed to stabilize the soil.

Material Storage Areas and Practices

- Liquids, petroleum products, and substances listed in 40 CFR Parts 110, 117, or 302 should be stored in approved containers and drums and should not be overfilled. Containers and drums should be placed in temporary containment facilities for storage.
- A temporary containment facility should provide for a spill containment volume able to contain precipitation from a 25-year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest container within its boundary, whichever is greater.
- A temporary containment facility should be impervious to the materials stored therein for a minimum contact time of 72 hours.
- A temporary containment facility should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be collected and placed into drums. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. All collected liquids or non-hazardous liquids should be sent to an approved disposal site.
- Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.
- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.
- Materials should be covered prior to, and during rain events.
- Materials should be stored in their original containers and the original product labels should be maintained in place in a legible condition. Damaged or otherwise illegible labels should be replaced immediately.

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- Bagged and boxed materials should be stored on pallets and should not be allowed to accumulate on the ground. To provide protection from wind and rain throughout the rainy season, bagged and boxed materials should be covered during non-working days and prior to and during rain events.
- Stockpiles should be protected in accordance with WM-3, Stockpile Management.
- Materials should be stored indoors within existing structures or completely enclosed storage sheds when available.
- Proper storage instructions should be posted at all times in an open and conspicuous location.
- An ample supply of appropriate spill clean up material should be kept near storage areas.
- Also see WM-6, Hazardous Waste Management, for storing of hazardous wastes.

Material Delivery Practices

- Keep an accurate, up-to-date inventory of material delivered and stored onsite.
- Arrange for employees trained in emergency spill cleanup procedures to be present when dangerous materials or liquid chemicals are unloaded.

Spill Cleanup

- Contain and clean up any spill immediately.
- Properly remove and dispose of any hazardous materials or contaminated soil if significant residual materials remain on the ground after construction is complete. See WM-7, Contaminated Soil Management.
- See WM-4, Spill Prevention and Control, for spills of chemicals and/or hazardous materials.
- If spills or leaks of materials occur that are not contained and could discharge to surface waters, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

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Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Keep storage areas clean and well organized, including a current list of all materials onsite.
- Inspect labels on containers for legibility and accuracy.
- Repair or replace perimeter controls, containment structures, covers, and liners as needed to maintain proper function.

References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

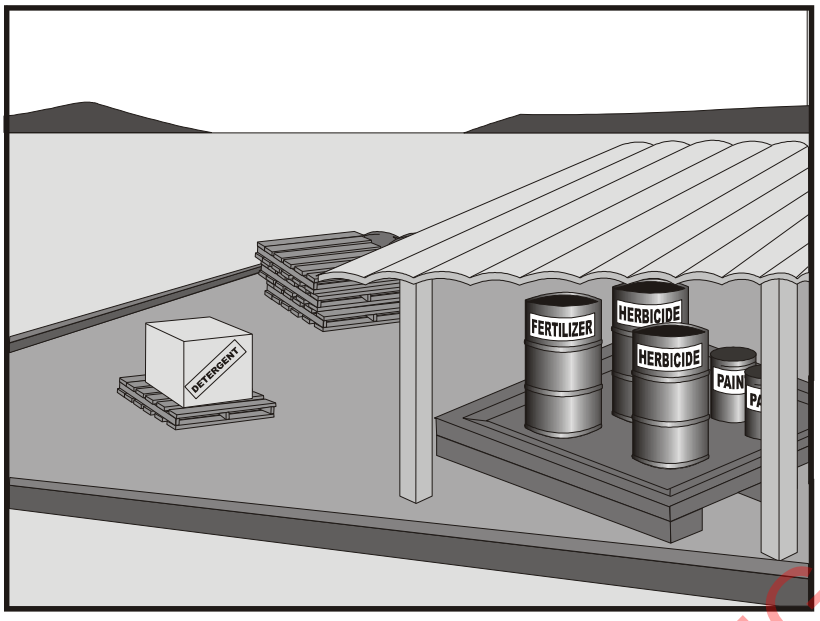
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Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance, Working Group Working Paper; USEPA, April 1992.

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

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Material Use WM-2



Categories

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 Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Prevent or reduce the discharge of pollutants to the storm drain system or watercourses from material use by using alternative products, minimizing hazardous material use onsite, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for use at all construction projects. These procedures apply when the following materials are used or prepared onsite:

- Pesticides and herbicides
- Fertilizers
- Detergents
- Petroleum products such as fuel, oil, and grease
- Asphalt and other concrete components
- Other hazardous chemicals such as acids, lime, glues, adhesives, paints, solvents, and curing compounds
- Other materials that may be detrimental if released to the environment

Limitations

Safer alternative building and construction products may not be available or suitable in every instance.

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Implementation

The following steps should be taken to minimize risk:

- Minimize use of hazardous materials onsite.
- Follow manufacturer instructions regarding uses, protective equipment, ventilation, flammability, and mixing of chemicals.
- Train personnel who use pesticides. The California Department of Pesticide Regulation and county agricultural commissioners license pesticide dealers, certify pesticide applicators, and conduct onsite inspections.
- The preferred method of termiticide application is soil injection near the existing or proposed structure foundation/slab; however, if not feasible, soil drench application of termiticides should follow EPA label guidelines and the following recommendations (most of which are applicable to most pesticide applications):
  - Do not treat soil that is water-saturated or frozen.
  - Application shall not commence within 24-hours of a predicted precipitation event with a 40% or greater probability. Weather tracking must be performed on a daily basis prior to termiticide application and during the period of termiticide application.
  - Do not allow treatment chemicals to runoff from the target area. Apply proper quantity to prevent excess runoff. Provide containment for and divert stormwater from application areas using berms or diversion ditches during application.
  - Dry season: Do not apply within 10 feet of storm drains. Do not apply within 25 feet of aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds).
  - Wet season: Do not apply within 50 feet of storm drains or aquatic habitats (such as, but not limited to, lakes; reservoirs; rivers; permanent streams; marshes or ponds; estuaries; and commercial fish farm ponds) unless a vegetative buffer is present (if so, refer to dry season requirements).
  - Do not make on-grade applications when sustained wind speeds are above 10 mph (at application site) at nozzle end height.
  - Cover treatment site prior to a rain event in order to prevent run-off of the pesticide into non-target areas. The treated area should be limited to a size that can be backfilled and/or covered by the end of the work shift. Backfilling or covering of the treated area shall be done by the end of the same work shift in which the application is made.
  - The applicator must either cover the soil him/herself or provide written notification of the above requirement to the contractor on site and to the person commissioning the application (if different than the contractor). If notice is provided to the contractor or the person commissioning the application, then they are responsible under the Federal Insecticide Fungicide, and Rodenticide Act (FIFRA) to ensure that: 1) if the concrete slab cannot be poured over the treated soil within 24 hours of application, the treated soil is

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covered with a waterproof covering (such as polyethylene sheeting), and 2) the treated soil is covered if precipitation is predicted to occur before the concrete slab is scheduled to be poured.

- Do not over-apply fertilizers, herbicides, and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over-application is expensive and environmentally harmful. Unless on steep slopes, till fertilizers into the soil rather than hydraulic application. Apply surface dressings in several smaller applications, as opposed to one large application, to allow time for infiltration and to avoid excess material being carried offsite by runoff. Do not apply these chemicals before predicted rainfall.
- Train employees and subcontractors in proper material use.
- Supply Material Safety Data Sheets (MSDS) for all materials.
- Dispose of latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths, when thoroughly dry and are no longer hazardous, with other construction debris.
- Do not remove the original product label; it contains important safety and disposal information. Use the entire product before disposing of the container.
- Mix paint indoors or in a containment area. Never clean paintbrushes or rinse paint containers into a street, gutter, storm drain, or watercourse. Dispose of any paint thinners, residue, and sludge(s) that cannot be recycled, as hazardous waste.
- For water-based paint, clean brushes to the extent practicable, and rinse to a drain leading to a sanitary sewer where permitted or contain for proper disposal off site. For oil-based paints, clean brushes to the extent practicable, and filter and reuse thinners and solvents.
- Use recycled and less hazardous products when practical. Recycle residual paints, solvents, non-treated lumber, and other materials.
- Use materials only where and when needed to complete the construction activity. Use safer alternative materials as much as possible. Reduce or eliminate use of hazardous materials onsite when practical.
- Document the location, time, chemicals applied, and applicator's name and qualifications.
- Keep an ample supply of spill clean up material near use areas. Train employees in spill clean up procedures.
- Avoid exposing applied materials to rainfall and runoff unless sufficient time has been allowed for them to dry.
- Discontinue use of erodible landscape material within 2 days prior to a forecasted rain event and materials should be covered and/or bermed.
- Provide containment for material use areas such as masons' areas or paint mixing/preparation areas to prevent materials/pollutants from entering stormwater.

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Inspection and Maintenance

- Inspect and verify that activity-based BMPs are in place prior to the commencement of associated activities.
- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Ensure employees and subcontractors throughout the job are using appropriate practices.

References and Additional Resources

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.

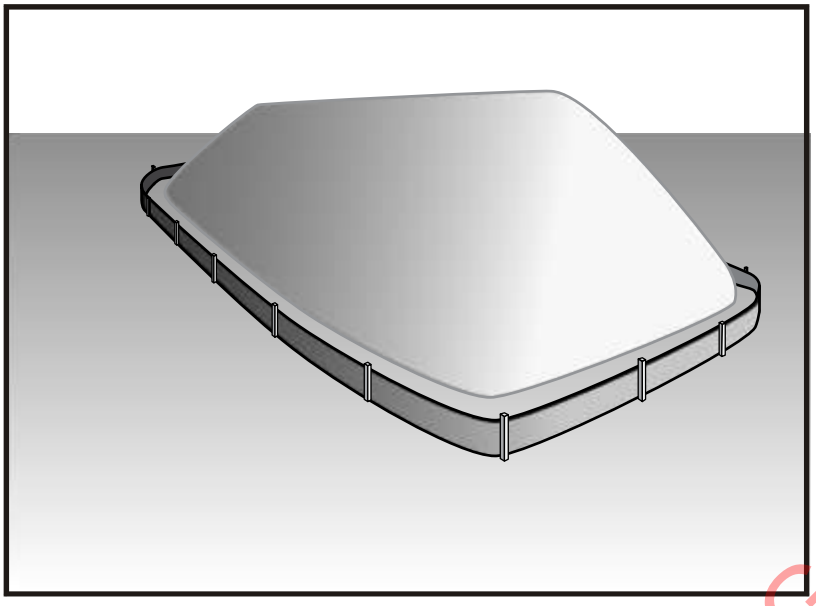
Comments on Risk Assessments Risk Reduction Options for Cypermethrin: Docket No. OPP–2005–0293; California Stormwater Quality Association (CASQA) letter to USEPA, 2006.Environmental Hazard and General Labeling for Pyrethroid Non-Agricultural Outdoor Products, EPA-HQ-OPP-2008-0331-0021; USEPA, 2008.

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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

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Stockpile Management WM-3



Treat Categories

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 Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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Description and Purpose

Stockpile management procedures and practices are designed to reduce or eliminate air and stormwater pollution from stockpiles of soil, soil amendments, sand, paving materials such as Portland cement concrete (PCC) rubble, asphalt concrete (AC), asphalt concrete rubble, aggregate base, aggregate sub base or pre-mixed aggregate, asphalt minder (so called "cold mix" asphalt), and pressure treated wood.

Suitable Applications

Implement in all projects that stockpile soil and other loose materials.

Limitations

- Plastic sheeting as a stockpile protection is temporary and hard to manage in windy conditions. Where plastic is used, consider use of plastic tarps with nylon reinforcement which may be more durable than standard sheeting.
- Plastic sheeting can increase runoff volume due to lack of infiltration and potentially cause perimeter control failure.
- Plastic sheeting breaks down faster in sunlight.
- The use of Plastic materials and photodegradable plastics should be avoided.

Implementation

Protection of stockpiles is a year-round requirement. To properly manage stockpiles:

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- On larger sites, a minimum of 50 ft separation from concentrated flows of stormwater, drainage courses, and inlets is recommended.
- After 14 days of inactivity, a stockpile is non-active and requires further protection described below. All stockpiles are required to be protected as non-active stockpiles immediately if they are not scheduled to be used within 14 days.
- Protect all stockpiles from stormwater run-on using temporary perimeter sediment barriers such as compost berms (SE-13), temporary silt dikes (SE-12), fiber rolls (SE-5), silt fences (SE-1), sandbags (SE-8), gravel bags (SE-6), or biofilter bags (SE-14). Refer to the individual fact sheet for each of these controls for installation information.
- Implement wind erosion control practices as appropriate on all stockpiled material. For specific information, see WE-1, Wind Erosion Control.
- Manage stockpiles of contaminated soil in accordance with WM-7, Contaminated Soil Management.
- Place bagged materials on pallets and under cover.
- Ensure that stockpile coverings are installed securely to protect from wind and rain.
- Some plastic covers withstand weather and sunlight better than others. Select cover materials or methods based on anticipated duration of use.

Protection of Non-Active Stockpiles

A stockpile is considered non-active if it either is not used for 14 days or if it is scheduled not to be used for 14 days or more. Stockpiles need to be protected immediately if they are not scheduled to be used within 14 days. Non-active stockpiles of the identified materials should be protected as follows:

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Soil stockpiles

- Soil stockpiles should be covered or protected with soil stabilization measures and a temporary perimeter sediment barrier at all times.
- Temporary vegetation should be considered for topsoil piles that will be stockpiled for extended periods.

Stockpiles of Portland cement concrete rubble, asphalt concrete, asphalt concrete rubble, aggregate base, or aggregate sub base

- Stockpiles should be covered and protected with a temporary perimeter sediment barrier at all times.

Stockpiles of "cold mix"

- Cold mix stockpiles should be placed on and covered with plastic sheeting or comparable material at all times and surrounded by a berm.

Stockpiles of fly ash, stucco, hydrated lime

- Stockpiles of materials that may raise the pH of runoff (i.e., basic materials) should be covered with plastic and surrounded by a berm.

Stockpiles/Storage of treated wood

- Treated wood should be covered with plastic sheeting or comparable material at all times and surrounded by a berm.

Protection of Active Stockpiles

A stockpile is active when it is being used or is scheduled to be used within 14 days of the previous use. Active stockpiles of the identified materials should be protected as follows:

- All stockpiles should be covered and protected with a temporary linear sediment barrier prior to the onset of precipitation.
- Stockpiles of "cold mix" and treated wood, and basic materials should be placed on and covered with plastic sheeting or comparable material and surrounded by a berm prior to the onset of precipitation.
- The downstream perimeter of an active stockpile should be protected with a linear sediment barrier or berm and runoff should be diverted around or away from the stockpile on the upstream perimeter.

Inspection and Maintenance

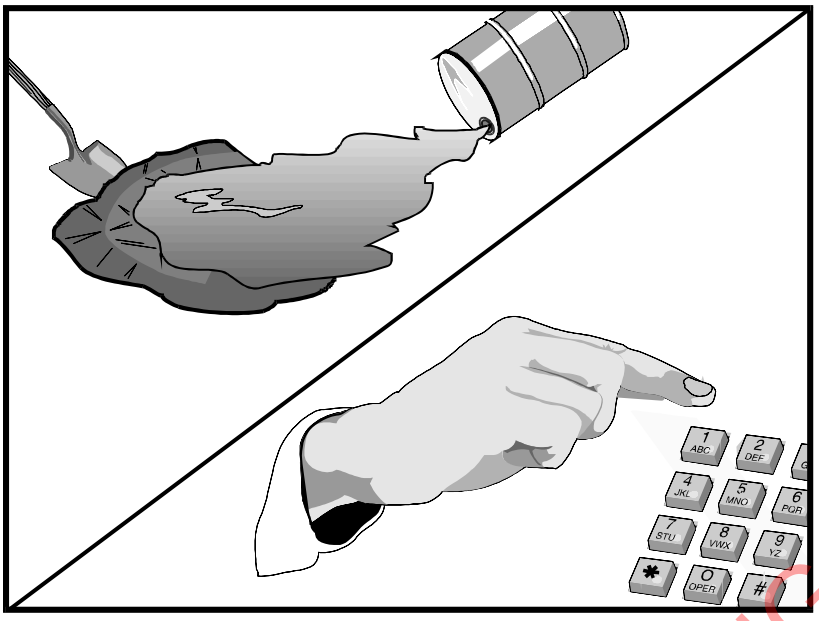
- Stockpiles must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- It may be necessary to inspect stockpiles covered with plastic sheeting more frequently during certain conditions (for example, high winds or extreme heat).
- Repair and/or replace perimeter controls and covers as needed to keep them functioning properly.
- Sediment shall be removed when it reaches one-third of the barrier height.

FOR BIDDING PURPOSES ONLY

References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

Spill Prevention and Control WM-4



Categories

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

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Description and Purpose

Prevent or reduce the discharge of pollutants to drainage systems or watercourses from leaks and spills by reducing the chance for spills, stopping the source of spills, containing and cleaning up spills, properly disposing of spill materials, and training employees.

This best management practice covers only spill prevention and control. However, WM-1, Materials Delivery and Storage, and WM-2, Material Use, also contain useful information, particularly on spill prevention. For information on wastes, see the waste management BMPs in this section.

Suitable Applications

This BMP is suitable for all construction projects. Spill control procedures are implemented anytime chemicals or hazardous substances are stored on the construction site, including the following materials:

- Soil stabilizers/binders
- Dust palliatives
- Herbicides
- Growth inhibitors
- Fertilizers
- Deicing/anti-icing chemicals

- Fuels
- Lubricants
- Other petroleum distillates

Limitations

- In some cases, it may be necessary to use a private spill cleanup company.
- This BMP applies to spills caused by the contractor and subcontractors.
- Procedures and practices presented in this BMP are general. Contractor should identify appropriate practices for the specific materials used or stored onsite

Implementation

The following steps will help reduce the stormwater impacts of leaks and spills:

Education

- Be aware that different materials pollute in different amounts. Make sure that each employee knows what a "significant spill" is for each material they use, and what is the appropriate response for "significant" and "insignificant" spills.
- Educate employees and subcontractors on potential dangers to humans and the environment from spills and leaks.
- Hold regular meetings to discuss and reinforce appropriate disposal procedures (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.
- Have contractor's superintendent or representative oversee and enforce proper spill prevention and control measures.

General Measures

- To the extent that the work can be accomplished safely, spills of oil, petroleum products, substances listed under 40 CFR parts 110,117, and 302, and sanitary and septic wastes should be contained and cleaned up immediately.
- Store hazardous materials and wastes in covered containers and protect from vandalism.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- Train employees in spill prevention and cleanup.
- Designate responsible individuals to oversee and enforce control measures.
- Spills should be covered and protected from stormwater runon during rainfall to the extent that it doesn't compromise clean up activities.
- Do not bury or wash spills with water.

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- Store and dispose of used clean up materials, contaminated materials, and recovered spill material that is no longer suitable for the intended purpose in conformance with the provisions in applicable BMPs.
- Do not allow water used for cleaning and decontamination to enter storm drains or watercourses. Collect and dispose of contaminated water in accordance with WM-10, Liquid Waste Management.
- Contain water overflow or minor water spillage and do not allow it to discharge into drainage facilities or watercourses.
- Place proper storage, cleanup, and spill reporting instructions for hazardous materials stored or used on the project site in an open, conspicuous, and accessible location.
- Keep waste storage areas clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored. Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.

Cleanup

- Clean up leaks and spills immediately.
- Use a rag for small spills on paved surfaces, a damp mop for general cleanup, and absorbent material for larger spills. If the spilled material is hazardous, then the used cleanup materials are also hazardous and must be sent to either a certified laundry (rags) or disposed of as hazardous waste.
- Never hose down or bury dry material spills. Clean up as much of the material as possible and dispose of properly. See the waste management BMPs in this section for specific information.

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Minor Spills

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spill.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill.
  - Recover spilled materials.
  - Clean the contaminated area and properly dispose of contaminated materials.

Semi-Significant Spills

- Semi-significant spills still can be controlled by the first responder along with the aid of other personnel such as laborers and the foreman, etc. This response may require the cessation of all other activities.

- Spills should be cleaned up immediately:
  - Contain spread of the spill.
  - Notify the project foreman immediately.
  - If the spill occurs on paved or impermeable surfaces, clean up using "dry" methods (absorbent materials, cat litter and/or rags). Contain the spill by encircling with absorbent materials and do not let the spill spread widely.
  - If the spill occurs in dirt areas, immediately contain the spill by constructing an earthen dike. Dig up and properly dispose of contaminated soil.
  - If the spill occurs during rain, cover spill with tarps or other material to prevent contaminating runoff.

Significant/Hazardous Spills

- For significant or hazardous spills that cannot be controlled by personnel in the immediate vicinity, the following steps should be taken:
  - Notify the local emergency response by dialing 911. In addition to 911, the contractor will notify the proper county officials. It is the contractor's responsibility to have all emergency phone numbers at the construction site.
  - Notify the Governor's Office of Emergency Services Warning Center, (916) 845-8911.
  - For spills of federal reportable quantities, in conformance with the requirements in 40 CFR parts 110,119, and 302, the contractor should notify the National Response Center at (800) 424-8802.
  - Notification should first be made by telephone and followed up with a written report.
  - The services of a spill's contractor or a Haz-Mat team should be obtained immediately. Construction personnel should not attempt to clean up until the appropriate and qualified staffs have arrived at the job site.
  - Other agencies which may need to be consulted include, but are not limited to, the Fire Department, the Public Works Department, the Coast Guard, the Highway Patrol, the City/County Police Department, Department of Toxic Substances, California Division of Oil and Gas, Cal/OSHA, etc.

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Reporting

- Report significant spills to local agencies, such as the Fire Department; they can assist in cleanup.
- Federal regulations require that any significant oil spill into a water body or onto an adjoining shoreline be reported to the National Response Center (NRC) at 800-424-8802 (24 hours).

Use the following measures related to specific activities:

Vehicle and Equipment Maintenance

- If maintenance must occur onsite, use a designated area and a secondary containment, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Regularly inspect onsite vehicles and equipment for leaks and repair immediately
- Check incoming vehicles and equipment (including delivery trucks, and employee and subcontractor vehicles) for leaking oil and fluids. Do not allow leaking vehicles or equipment onsite.
- Always use secondary containment, such as a drain pan or drop cloth, to catch spills or leaks when removing or changing fluids.
- Place drip pans or absorbent materials under paving equipment when not in use.
- Use absorbent materials on small spills rather than hosing down or burying the spill. Remove the absorbent materials promptly and dispose of properly.
- Promptly transfer used fluids to the proper waste or recycling drums. Don't leave full drip pans or other open containers lying around
- Oil filters disposed of in trashcans or dumpsters can leak oil and pollute stormwater. Place the oil filter in a funnel over a waste oil-recycling drum to drain excess oil before disposal. Oil filters can also be recycled. Ask the oil supplier or recycler about recycling oil filters.
- Store cracked batteries in a non-leaking secondary container. Do this with all cracked batteries even if you think all the acid has drained out. If you drop a battery, treat it as if it is cracked. Put it into the containment area until you are sure it is not leaking.

FOR BIDDING PURPOSES ONLY

Vehicle and Equipment Fueling

- If fueling must occur onsite, use designate areas, located away from drainage courses, to prevent the runon of stormwater and the runoff of spills.
- Discourage "topping off" of fuel tanks.
- Always use secondary containment, such as a drain pan, when fueling to catch spills/ leaks.

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 BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur.

- Keep ample supplies of spill control and cleanup materials onsite, near storage, unloading, and maintenance areas.
- Update your spill prevention and control plan and stock cleanup materials as changes occur in the types of chemicals onsite.

References and Additional Resources

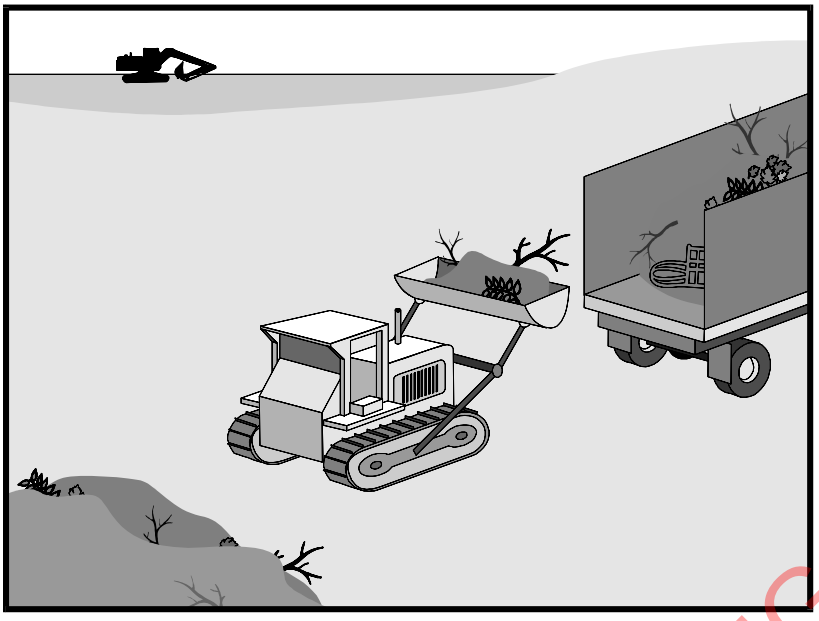
Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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.

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

FOR BIDDING PURPOSES ONLY

Solid Waste Management WM-5



Categories

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

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FOR BIDDING PURPOSES ONLY

Description and Purpose

Solid waste management procedures and practices are designed to prevent or reduce the discharge of pollutants to stormwater from solid or construction waste by providing designated waste collection areas and containers, arranging for regular disposal, and training employees and subcontractors.

Suitable Applications

This BMP is suitable for construction sites where the following wastes are generated or stored:

- Solid waste generated from trees and shrubs removed during land clearing, demolition of existing structures (rubble), and building construction
- Packaging materials including wood, paper, and plastic
- Scrap or surplus building materials including scrap metals, rubber, plastic, glass pieces, and masonry products
- Domestic wastes including food containers such as beverage cans, coffee cups, paper bags, plastic wrappers, and cigarettes
- Construction wastes including brick, mortar, timber, steel and metal scraps, pipe and electrical cuttings, non-hazardous equipment parts, styrofoam and other materials used to transport and package construction materials

- Highway planting wastes, including vegetative material, plant containers, and packaging materials

Limitations

Temporary stockpiling of certain construction wastes may not necessitate stringent drainage related controls during the non-rainy season or in desert areas with low rainfall.

Implementation

The following steps will help keep a clean site and reduce stormwater pollution:

- Select designated waste collection areas onsite.
- Inform trash-hauling contractors that you will accept only watertight dumpsters for onsite use. Inspect dumpsters for leaks and repair any dumpster that is not watertight.
- Locate containers in a covered area or in a secondary containment.
- Provide an adequate number of containers with lids or covers that can be placed over the container to keep rain out or to prevent loss of wastes when it is windy.
- Cover waste containers at the end of each work day and when it is raining.
- Plan for additional containers and more frequent pickup during the demolition phase of construction.
- Collect site trash daily, especially during rainy and windy conditions.
- Remove this solid waste promptly since erosion and sediment control devices tend to collect litter.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Do not hose out dumpsters on the construction site. Leave dumpster cleaning to the trash hauling contractor.
- Arrange for regular waste collection before containers overflow.
- Clean up immediately if a container does spill.
- Make sure that construction waste is collected, removed, and disposed of only at authorized disposal areas.

FOR BIDDING PURPOSES ONLY

Education

- Have the contractor's superintendent or representative oversee and enforce proper solid waste management procedures and practices.
- Instruct employees and subcontractors on identification of solid waste and hazardous waste.
- Educate employees and subcontractors on solid waste storage and disposal procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).
- Require that employees and subcontractors follow solid waste handling and storage procedures.
- Prohibit littering by employees, subcontractors, and visitors.
- Minimize production of solid waste materials wherever possible.

Collection, Storage, and Disposal

- Littering on the project site should be prohibited.
- To prevent clogging of the storm drainage system, litter and debris removal from drainage grates, trash racks, and ditch lines should be a priority.
- Trash receptacles should be provided in the contractor's yard, field trailer areas, and at locations where workers congregate for lunch and break periods.
- Litter from work areas within the construction limits of the project site should be collected and placed in watertight dumpsters at least weekly, regardless of whether the litter was generated by the contractor, the public, or others. Collected litter and debris should not be placed in or next to drain inlets, stormwater drainage systems, or watercourses.
- Dumpsters of sufficient size and number should be provided to contain the solid waste generated by the project.
- Full dumpsters should be removed from the project site and the contents should be disposed of by the trash hauling contractor.
- Construction debris and waste should be removed from the site biweekly or more frequently as needed.
- Construction material visible to the public should be stored or stacked in an orderly manner.
- Stormwater runon should be prevented from contacting stored solid waste through the use of berms, dikes, or other temporary diversion structures or through the use of measures to elevate waste from site surfaces.
- Solid waste storage areas should be located at least 50 ft from drainage facilities and watercourses and should not be located in areas prone to flooding or ponding.
- Except during fair weather, construction and highway planting waste not stored in watertight dumpsters should be securely covered from wind and rain by covering the waste with tarps or plastic.
- Segregate potentially hazardous waste from non-hazardous construction site waste.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.

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- For disposal of hazardous waste, see WM-6, Hazardous Waste Management. Have hazardous waste hauled to an appropriate disposal and/or recycling facility.
- Salvage or recycle useful vegetation debris, packaging and surplus building materials when practical. For example, trees and shrubs from land clearing can be used as a brush barrier, or converted into wood chips, then used as mulch on graded areas. Wood pallets, cardboard boxes, and construction scraps can also be recycled.

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 BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Inspect construction waste area regularly.
- Arrange for regular waste collection.

References and Additional Resources

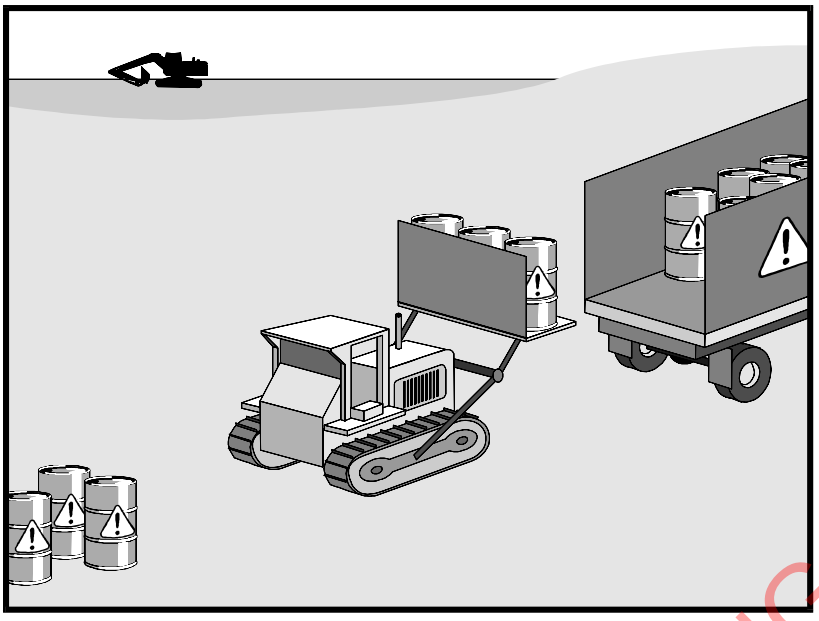
Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

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

FOR BIDDING PURPOSES ONLY

Hazardous Waste Management WM-6



Categories

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

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FOR BIDDING PURPOSES ONLY

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from hazardous waste through proper material use, waste disposal, and training of employees and subcontractors.

Suitable Applications

This best management practice (BMP) applies to all construction projects. Hazardous waste management practices are implemented on construction projects that generate waste from the use of:

- Petroleum Products
- Asphalt Products
- Concrete Curing Compounds
- Pesticides
- Palliatives
- Acids
- Septic Wastes
- Paints
- Stains
- Solvents
- Wood Preservatives
- Roofing Tar
- Any materials deemed a hazardous waste in California, Title 22 Division 4.5, or listed in 40 CFR Parts 110, 117, 261, or 302

In addition, sites with existing structures may contain wastes, which must be disposed of in accordance with federal, state, and local regulations. These wastes include:

- Sandblasting grit mixed with lead-, cadmium-, or chromium-based paints
- Asbestos
- PCBs (particularly in older transformers)

Limitations

- Hazardous waste that cannot be reused or recycled must be disposed of by a licensed hazardous waste hauler.
- Nothing in this BMP relieves the contractor from responsibility for compliance with federal, state, and local laws regarding storage, handling, transportation, and disposal of hazardous wastes.
- This BMP does not cover aerially deposited lead (ADL) soils. For ADL soils refer to WM-7, Contaminated Soil Management.

Implementation

The following steps will help reduce stormwater pollution from hazardous wastes:

Material Use

- Wastes should be stored in sealed containers constructed of a suitable material and should be labeled as required by Title 22 CCR, Division 4.5 and 49 CFR Parts 172, 173, 178, and 179.
- All hazardous waste should be stored, transported, and disposed as required in Title 22 CCR, Division 4.5 and 49 CFR 261-263.
- Waste containers should be stored in temporary containment facilities that should comply with the following requirements:
  - Temporary containment facility should provide for a spill containment volume equal to 1.5 times the volume of all containers able to contain precipitation from a 25-year storm event, plus the greater of 10% of the aggregate volume of all containers or 100% of the capacity of the largest tank within its boundary, whichever is greater.
  - Temporary containment facility should be impervious to the materials stored there for a minimum contact time of 72 hours.
  - Temporary containment facilities should be maintained free of accumulated rainwater and spills. In the event of spills or leaks, accumulated rainwater and spills should be placed into drums after each rainfall. These liquids should be handled as a hazardous waste unless testing determines them to be non-hazardous. Non-hazardous liquids should be sent to an approved disposal site.
  - Sufficient separation should be provided between stored containers to allow for spill cleanup and emergency response access.

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- Incompatible materials, such as chlorine and ammonia, should not be stored in the same temporary containment facility.

- Throughout the rainy season, temporary containment facilities should be covered during non-working days, and prior to rain events. Covered facilities may include use of plastic tarps for small facilities or constructed roofs with overhangs.

- Drums should not be overfilled, and wastes should not be mixed.

- Unless watertight, containers of dry waste should be stored on pallets.

- Do not over-apply herbicides and pesticides. Prepare only the amount needed. Follow the recommended usage instructions. Over application is expensive and environmentally harmful. Apply surface dressings in several smaller applications, as opposed to one large application. Allow time for infiltration and avoid excess material being carried offsite by runoff. Do not apply these chemicals just before it rains. People applying pesticides must be certified in accordance with federal and state regulations.

- Paint brushes and equipment for water and oil-based paints should be cleaned within a contained area and should not be allowed to contaminate site soils, watercourses, or drainage systems. Waste paints, thinners, solvents, residues, and sludges that cannot be recycled or reused should be disposed of as hazardous waste. When thoroughly dry, latex paint and paint cans, used brushes, rags, absorbent materials, and drop cloths should be disposed of as solid waste.

- Do not clean out brushes or rinse paint containers into the dirt, street, gutter, storm drain, or stream. "Paint out" brushes as much as possible. Rinse water-based paints to the sanitary sewer. Filter and reuse thinners and solvents. Dispose of excess oil-based paints and sludge as hazardous waste.

- The following actions should be taken with respect to temporary contaminant:

  - Ensure that adequate hazardous waste storage volume is available.

  - Ensure that hazardous waste collection containers are conveniently located.

  - Designate hazardous waste storage areas onsite away from storm drains or watercourses and away from moving vehicles and equipment to prevent accidental spills.

  - Minimize production or generation of hazardous materials and hazardous waste on the job site.

  - Use containment berms in fueling and maintenance areas and where the potential for spills is high.

  - Segregate potentially hazardous waste from non-hazardous construction site debris.

  - Keep liquid or semi-liquid hazardous waste in appropriate containers (closed drums or similar) and under cover.

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- Clearly label all hazardous waste containers with the waste being stored and the date of accumulation.
- Place hazardous waste containers in secondary containment.
- Do not allow potentially hazardous waste materials to accumulate on the ground.
- Do not mix wastes.
- Use all of the product before disposing of the container.
- Do not remove the original product label; it contains important safety and disposal information.

Waste Recycling Disposal

- Select designated hazardous waste collection areas onsite.
- Hazardous materials and wastes should be stored in covered containers and protected from vandalism.
- Place hazardous waste containers in secondary containment.
- Do not mix wastes, this can cause chemical reactions, making recycling impossible and complicating disposal.
- Recycle any useful materials such as used oil or water-based paint.
- Make sure that toxic liquid wastes (used oils, solvents, and paints) and chemicals (acids, pesticides, additives, curing compounds) are not disposed of in dumpsters designated for construction debris.
- Arrange for regular waste collection before containers overflow.
- Make sure that hazardous waste (e.g., excess oil-based paint and sludge) is collected, removed, and disposed of only at authorized disposal areas.

FOR BIDDING PURPOSES ONLY

Disposal Procedures

- Waste should be disposed of by a licensed hazardous waste transporter at an authorized and licensed disposal facility or recycling facility utilizing properly completed Uniform Hazardous Waste Manifest forms.
- A Department of Health Services certified laboratory should sample waste to determine the appropriate disposal facility.
- Properly dispose of rainwater in secondary containment that may have mixed with hazardous waste.
- Attention is directed to "Hazardous Material", "Contaminated Material", and "Aerially Deposited Lead" of the contract documents regarding the handling and disposal of hazardous materials.

Education

- Educate employees and subcontractors on hazardous waste storage and disposal procedures.
- Educate employees and subcontractors on potential dangers to humans and the environment from hazardous wastes.
- Instruct employees and subcontractors on safety procedures for common construction site hazardous wastes.
- Instruct employees and subcontractors in identification of hazardous and solid waste.
- Hold regular meetings to discuss and reinforce hazardous waste management procedures (incorporate into regular safety meetings).
- The contractor's superintendent or representative should oversee and enforce proper hazardous waste management procedures and practices.
- Make sure that hazardous waste is collected, removed, and disposed of only at authorized disposal areas.
- Warning signs should be placed in areas recently treated with chemicals.
- Place a stockpile of spill cleanup materials where it will be readily accessible.
- If a container does spill, clean up immediately.

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 BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Inspect BMPs subject to non-stormwater discharge daily while non-stormwater discharges occur
- Hazardous waste should be regularly collected.
- A foreman or construction supervisor should monitor onsite hazardous waste storage and disposal procedures.
- Waste storage areas should be kept clean, well organized, and equipped with ample cleanup supplies as appropriate for the materials being stored.
- Perimeter controls, containment structures, covers, and liners should be repaired or replaced as needed to maintain proper function.
- Hazardous spills should be cleaned up and reported in conformance with the applicable Material Safety Data Sheet (MSDS) and the instructions posted at the project site.

FOR BIDDING PURPOSES ONLY

- The National Response Center, at (800) 424-8802, should be notified of spills of federal reportable quantities in conformance with the requirements in 40 CFR parts 110, 117, and 302. Also notify the Governors Office of Emergency Services Warning Center at (916) 845-8911.
- A copy of the hazardous waste manifests should be provided.

References and Additional Resources

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.

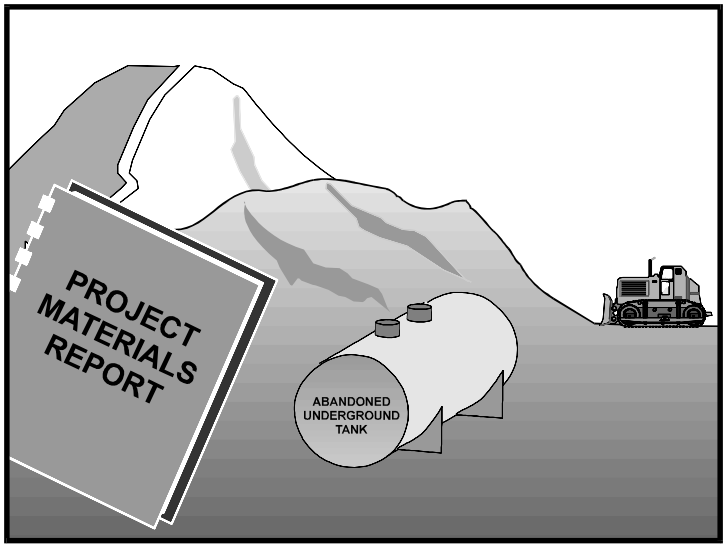
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Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.

FOR BIDDING PURPOSES ONLY

Contaminated Soil Management WM-7



Categories

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**

Description and Purpose

Prevent or reduce the discharge of pollutants to stormwater from contaminated soil and highly acidic or alkaline soils by conducting pre-construction surveys, inspecting excavations regularly, and remediating contaminated soil promptly.

Suitable Applications

Contaminated soil management is implemented on construction projects in highly urbanized or industrial areas where soil contamination may have occurred due to spills, illicit discharges, aerial deposition, past use and leaks from underground storage tanks.

Limitations

Contaminated soils that cannot be treated onsite must be disposed of offsite by a licensed hazardous waste hauler. The presence of contaminated soil may indicate contaminated water as well. See NS-2, Dewatering Operations, for more information.

The procedures and practices presented in this BMP are general. The contractor should identify appropriate practices and procedures for the specific contaminants known to exist or discovered onsite.

Implementation

Most owners and developers conduct pre-construction environmental assessments as a matter of routine. Contaminated soils are often identified during project planning and development with known locations identified in the plans, specifications and in the SWPPP. The contractor should review applicable reports and investigate appropriate call-outs in the

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	☑
Bacteria	☑
Oil and Grease	☑
Organics	☑

Potential Alternatives

None

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plans, specifications, and SWPPP. Recent court rulings holding contractors liable for cleanup costs when they unknowingly move contaminated soil highlight the need for contractors to confirm a site assessment is completed before earth moving begins.

The following steps will help reduce stormwater pollution from contaminated soil:

- Conduct thorough, pre-construction inspections of the site and review documents related to the site. If inspection or reviews indicated presence of contaminated soils, develop a plan before starting work.
- Look for contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
- Prevent leaks and spills. Contaminated soil can be expensive to treat and dispose of properly. However, addressing the problem before construction is much less expensive than after the structures are in place.
- The contractor may further identify contaminated soils by investigating:
  - Past site uses and activities
  - Detected or undetected spills and leaks
  - Acid or alkaline solutions from exposed soil or rock formations high in acid or alkaline forming elements
  - Contaminated soil as evidenced by discoloration, odors, differences in soil properties, abandoned underground tanks or pipes, or buried debris.
  - Suspected soils should be tested at a certified laboratory.

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Education

- Have employees and subcontractors complete a safety training program which meets 29 CFR 1910.120 and 8 CCR 5192 covering the potential hazards as identified, prior to performing any excavation work at the locations containing material classified as hazardous.
- Educate employees and subcontractors in identification of contaminated soil and on contaminated soil handling and disposal procedures.
- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

Handling Procedures for Material with Aerially Deposited Lead (ADL)

- Materials from areas designated as containing (ADL) may, if allowed by the contract special provisions, be excavated, transported, and used in the construction of embankments and/or backfill.
- Excavation, transportation, and placement operations should result in no visible dust.
- Caution should be exercised to prevent spillage of lead containing material during transport.

- Quality should be monitored during excavation of soils contaminated with lead.

Handling Procedures for Contaminated Soils

- Minimize onsite storage. Contaminated soil should be disposed of properly in accordance with all applicable regulations. All hazardous waste storage will comply with the requirements in Title 22, CCR, Sections 66265.250 to 66265.260.
- Test suspected soils at an approved certified laboratory.
- Work with the local regulatory agencies to develop options for treatment or disposal if the soil is contaminated.
- Avoid temporary stockpiling of contaminated soils or hazardous material.
- Take the following precautions if temporary stockpiling is necessary:
  - Cover the stockpile with plastic sheeting or tarps.
  - Install a berm around the stockpile to prevent runoff from leaving the area.
  - Do not stockpile in or near storm drains or watercourses.
- Remove contaminated material and hazardous material on exteriors of transport vehicles and place either into the current transport vehicle or into the excavation prior to the vehicle leaving the exclusion zone.
- Monitor the air quality continuously during excavation operations at all locations containing hazardous material.
- Procure all permits and licenses, pay all charges and fees, and give all notices necessary and incident to the due and lawful prosecution of the work, including registration for transporting vehicles carrying the contaminated material and the hazardous material.
- Collect water from decontamination procedures and treat or dispose of it at an appropriate disposal site.
- Collect non-reusable protective equipment, once used by any personnel, and dispose of at an appropriate disposal site.
- Install temporary security fence to surround and secure the exclusion zone. Remove fencing when no longer needed.
- Excavate, transport, and dispose of contaminated material and hazardous material in accordance with the rules and regulations of the following agencies (the specifications of these agencies supersede the procedures outlined in this BMP):
  - United States Department of Transportation (USDOT)
  - United States Environmental Protection Agency (USEPA)
  - California Environmental Protection Agency (CAL-EPA)

FOR BIDDING PURPOSES ONLY

- California Division of Occupation Safety and Health Administration (CAL-OSHA)
- Local regulatory agencies

Procedures for Underground Storage Tank Removals

- Prior to commencing tank removal operations, obtain the required underground storage tank removal permits and approval from the federal, state, and local agencies that have jurisdiction over such work.
- To determine if it contains hazardous substances, arrange to have tested, any liquid or sludge found in the underground tank prior to its removal.
- Following the tank removal, take soil samples beneath the excavated tank and perform analysis as required by the local agency representative(s).
- The underground storage tank, any liquid or sludge found within the tank, and all contaminated substances and hazardous substances removed during the tank removal and transported to disposal facilities permitted to accept such waste.

Water Control

- All necessary precautions and preventive measures should be taken to prevent the flow of water, including ground water, from mixing with hazardous substances or underground storage tank excavations. Such preventative measures may consist of, but are not limited to, berms, cofferdams, grout curtains, freeze walls, and seal course concrete or any combination thereof.
- If water does enter an excavation and becomes contaminated, such water, when necessary to proceed with the work, should be discharged to clean, closed top, watertight transportable holding tanks, treated, and disposed of in accordance with federal, state, and local laws.

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 BMPs in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.
- Arrange for contractor's Water Pollution Control Manager, foreman, and/or construction supervisor to monitor onsite contaminated soil storage and disposal procedures.
- Monitor air quality continuously during excavation operations at all locations containing hazardous material.
- Coordinate contaminated soils and hazardous substances/waste management with the appropriate federal, state, and local agencies.
- Implement WM-4, Spill Prevention and Control, to prevent leaks and spills as much as possible.

FOR BIDDING PURPOSES ONLY

References and Additional Resources

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.

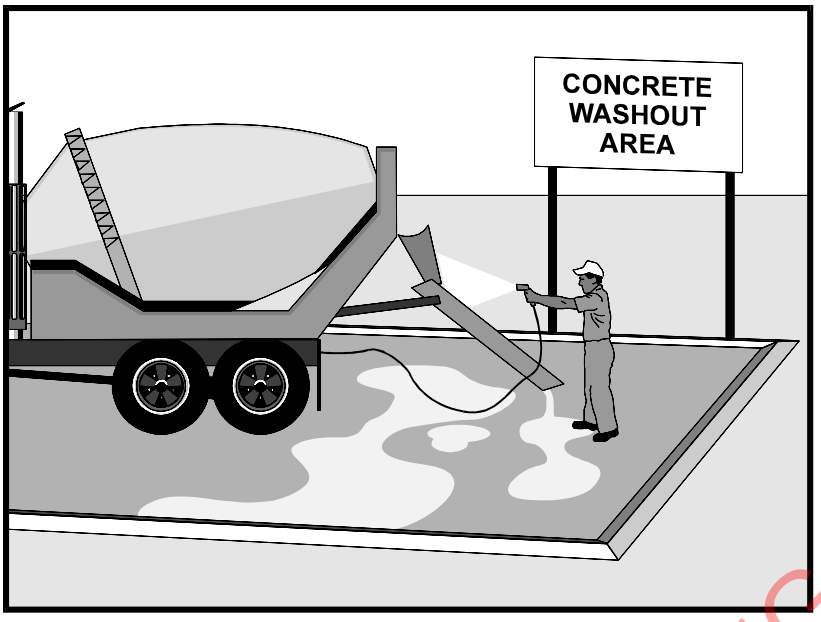
Processes, Procedures and Methods to Control Pollution Resulting from All Construction Activity, 430/9-73-007, USEPA, 1973.

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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

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Concrete Waste Management WM-8



Categories

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 Category**
☒ **Secondary Category**

Targeted Constituents

Sediment	☑
Nutrients	
Trash	
Metals	☑
Bacteria	
Oil and Grease	
Organics	

Potential Alternatives

None

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Description and Purpose

Prevent the discharge of pollutants to stormwater from concrete waste by conducting washout onsite or offsite in a designated area, and by employee and subcontractor training.

The General Permit incorporates Numeric Action Levels (NAL) for pH (see Section 2 of this handbook to determine your project's risk level and if you are subject to these requirements).

Many types of construction materials, including mortar, concrete, stucco, cement and block and their associated wastes have basic chemical properties that can raise pH levels outside of the permitted range. Additional care should be taken when managing these materials to prevent them from coming into contact with stormwater flows and raising pH to levels outside the accepted range.

Suitable Applications

Concrete waste management procedures and practices are implemented on construction projects where:

- Concrete is used as a construction material or where concrete dust and debris result from demolition activities.
- Slurries containing Portland cement concrete (PCC) are generated, such as from saw cutting, coring, grinding, grooving, and hydro-concrete demolition.
- Concrete trucks and other concrete-coated equipment are washed onsite.

- Mortar-mixing stations exist.
- Stucco mixing and spraying.
- See also NS-8, Vehicle and Equipment Cleaning.

Limitations

- Offsite washout of concrete wastes may not always be possible.
- Multiple washouts may be needed to assure adequate capacity and to allow for evaporation.

Implementation

The following steps will help reduce stormwater pollution from concrete wastes:

- Incorporate requirements for concrete waste management into material supplier and subcontractor agreements.
- Store dry and wet materials under cover, away from drainage areas. Refer to WM-1, Material Delivery and Storage for more information.
- Avoid mixing excess amounts of concrete.
- Perform washout of concrete trucks in designated areas only, where washout will not reach stormwater.
- Do not wash out concrete trucks into storm drains, open ditches, streets, streams or onto the ground. Trucks should always be washed out into designated facilities.
- Do not allow excess concrete to be dumped onsite, except in designated areas.
- For onsite washout:
  - On larger sites, it is recommended to locate washout areas at least 50 feet from storm drains, open ditches, or water bodies. Do not allow runoff from this area by constructing a temporary pit or bermed area large enough for liquid and solid waste.
  - Washout wastes into the temporary washout where the concrete can set, be broken up, and then disposed properly.
  - Washouts shall be implemented in a manner that prevents leaching to underlying soils. Washout containers must be water tight and washouts on or in the ground must be lined with a suitable impervious liner, typically a plastic type material.
- Do not wash sweepings from exposed aggregate concrete into the street or storm drain. Collect and return sweepings to aggregate base stockpile or dispose in the trash.
- See typical concrete washout installation details at the end of this fact sheet.

Education

- Educate employees, subcontractors, and suppliers on the concrete waste management techniques described herein.

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- Arrange for contractor's superintendent or representative to oversee and enforce concrete waste management procedures.
- Discuss the concrete management techniques described in this BMP (such as handling of concrete waste and washout) with the ready-mix concrete supplier before any deliveries are made.

Concrete Demolition Wastes

- Stockpile concrete demolition waste in accordance with BMP WM-3, Stockpile Management.
- Dispose of or recycle hardened concrete waste in accordance with applicable federal, state or local regulations.

Concrete Slurry Wastes

- PCC and AC waste should not be allowed to enter storm drains or watercourses.
- PCC and AC waste should be collected and disposed of or placed in a temporary concrete washout facility (as described in Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below).
- A foreman or construction supervisor should monitor onsite concrete working tasks, such as saw cutting, coring, grinding and grooving to ensure proper methods are implemented.
- Saw-cut concrete slurry should not be allowed to enter storm drains or watercourses. Residue from grinding operations should be picked up by means of a vacuum attachment to the grinding machine or by sweeping. Saw cutting residue should not be allowed to flow across the pavement and should not be left on the surface of the pavement. See also NS-3, Paving and Grinding Operations; and WM-10, Liquid Waste Management.
- Concrete slurry residue should be disposed in a temporary washout facility (as described in Onsite Temporary Concrete Washout Facility, Concrete Transit Truck Washout Procedures, below) and allowed to dry. Dispose of dry slurry residue in accordance with WM-5, Solid Waste Management.

Onsite Temporary Concrete Washout Facility, Transit Truck Washout Procedures

- Temporary concrete washout facilities should be located a minimum of 50 ft from storm drain inlets, open drainage facilities, and watercourses. Each facility should be located away from construction traffic or access areas to prevent disturbance or tracking.
- A sign should be installed adjacent to each washout facility to inform concrete equipment operators to utilize the proper facilities.
- Temporary concrete washout facilities should be constructed above grade or below grade at the option of the contractor. Temporary concrete washout facilities should be constructed and maintained in sufficient quantity and size to contain all liquid and concrete waste generated by washout operations.

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- Temporary washout facilities should have a temporary pit or bermed areas of sufficient volume to completely contain all liquid and waste concrete materials generated during washout procedures.
- Temporary washout facilities should be lined to prevent discharge to the underlying ground or surrounding area.
- Washout of concrete trucks should be performed in designated areas only.
- Only concrete from mixer truck chutes should be washed into concrete wash out.
- Concrete washout from concrete pumper bins can be washed into concrete pumper trucks and discharged into designated washout area or properly disposed of or recycled offsite.
- Once concrete wastes are washed into the designated area and allowed to harden, the concrete should be broken up, removed, and disposed of per WM-5, Solid Waste Management. Dispose of or recycle hardened concrete on a regular basis.
- Temporary Concrete Washout Facility (Type Above Grade)
  - Temporary concrete washout facility (type above grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft; however, smaller sites or jobs may only need a smaller washout facility. With any washout, always maintain a sufficient quantity and volume to contain all liquid and concrete waste generated by washout operations.
  - Materials used to construct the washout area should conform to the provisions detailed in their respective BMPs (e.g., SE-8 Sandbag Barrier).
  - Plastic lining material should be a minimum of 10 mil in polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.
  - Alternatively, portable removable containers can be used as above grade concrete washouts. Also called a "roll-off"; this concrete washout facility should be properly sealed to prevent leakage and should be removed from the site and replaced when the container reaches 75% capacity.
- Temporary Concrete Washout Facility (Type Below Grade)
  - Temporary concrete washout facilities (type below grade) should be constructed as shown on the details at the end of this BMP, with a recommended minimum length and minimum width of 10 ft. The quantity and volume should be sufficient to contain all liquid and concrete waste generated by washout operations.
  - Lath and flagging should be commercial type.
  - Plastic lining material should be a minimum of 10 mil polyethylene sheeting and should be free of holes, tears, or other defects that compromise the impermeability of the material.

FOR BIDDING PURPOSES ONLY

- The base of a washout facility should be free of rock or debris that may damage a plastic liner.

Removal of Temporary Concrete Washout Facilities

- When temporary concrete washout facilities are no longer required for the work, the hardened concrete should be removed and properly disposed or recycled in accordance with federal, state or local regulations. Materials used to construct temporary concrete washout facilities should be removed from the site of the work and properly disposed or recycled in accordance with federal, state or local regulations.

- Holes, depressions or other ground disturbance caused by the removal of the temporary concrete washout facilities should be backfilled and repaired.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Temporary concrete washout facilities should be maintained to provide adequate holding capacity with a minimum freeboard of 4 in. for above grade facilities and 12 in. for below grade facilities. Maintaining temporary concrete washout facilities should include removing and disposing of hardened concrete and returning the facilities to a functional condition. Hardened concrete materials should be removed and properly disposed or recycled in accordance with federal, state or local regulations.

- Washout facilities must be cleaned, or new facilities must be constructed and ready for use once the washout is 75% full.

- Inspect washout facilities for damage (e.g. torn liner, evidence of leaks, signage, etc.). Repair all identified damage.

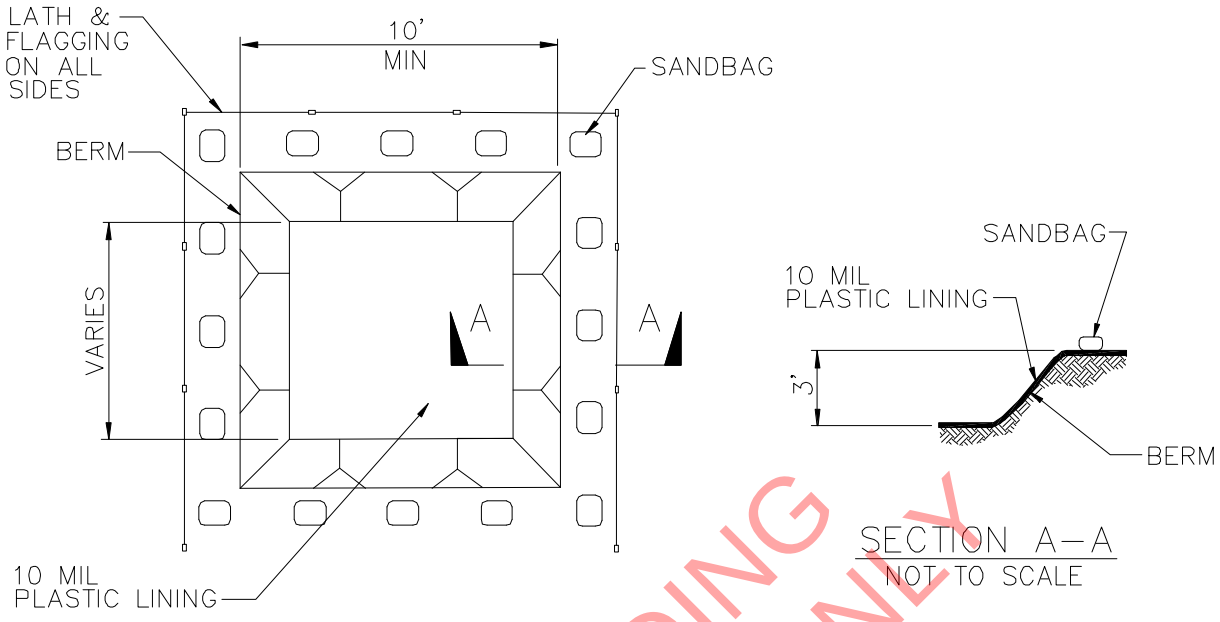
FOR BIDDING PURPOSES ONLY

References and Additional Resources

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.

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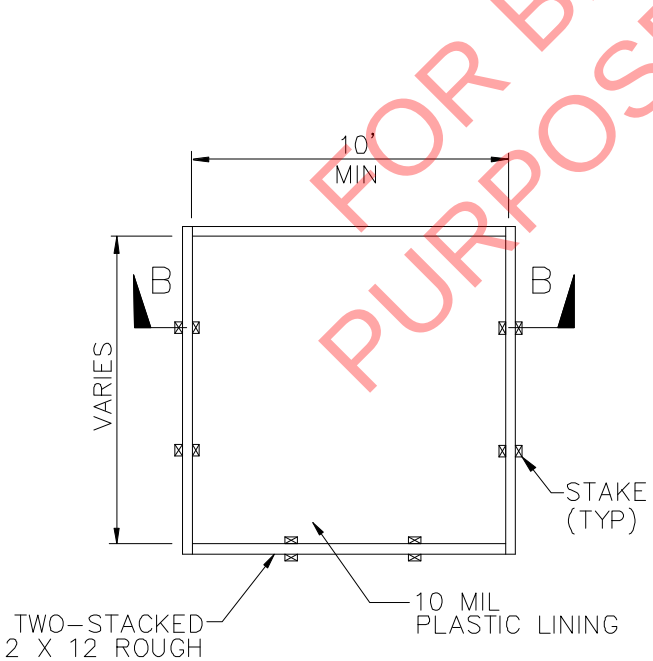
Stormwater Management for Construction Activities; Developing Pollution Prevention Plans and Best Management Practice, EPA 832-R-92005; USEPA, April 1992.



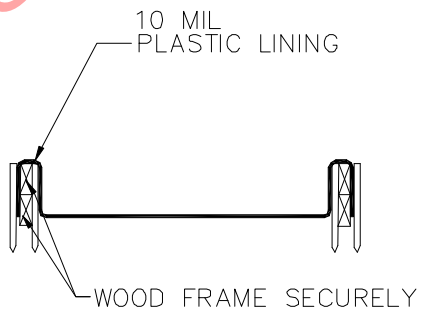
PLAN
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TYPE "BELOW GRADE"

SECTION A–A
NOT TO SCALE

FOR BIDDING PURPOSES ONLY



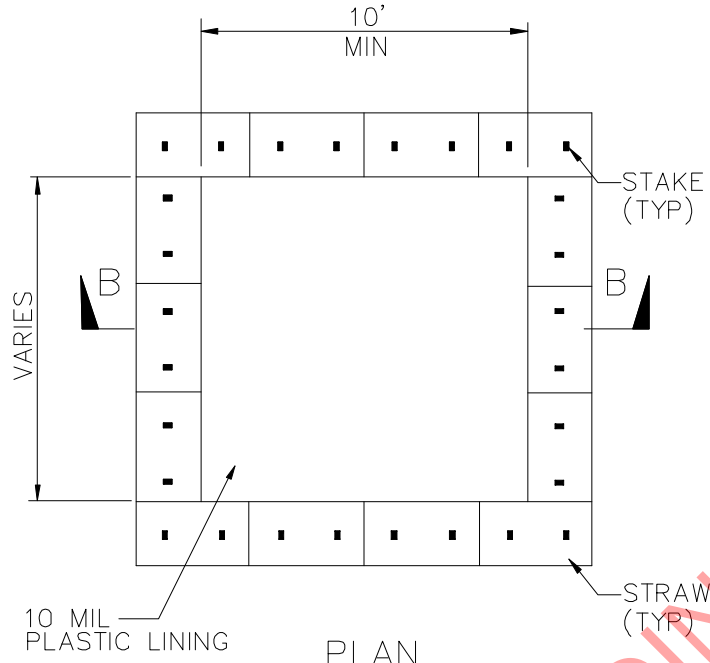
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE"



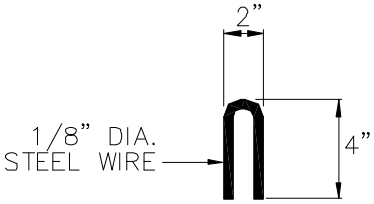
SECTION B–B
NOT TO SCALE

NOTES

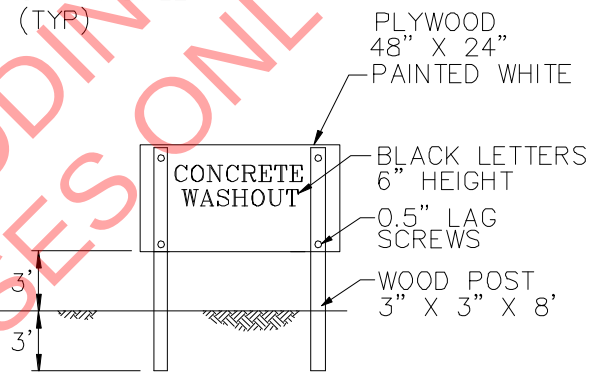
1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.



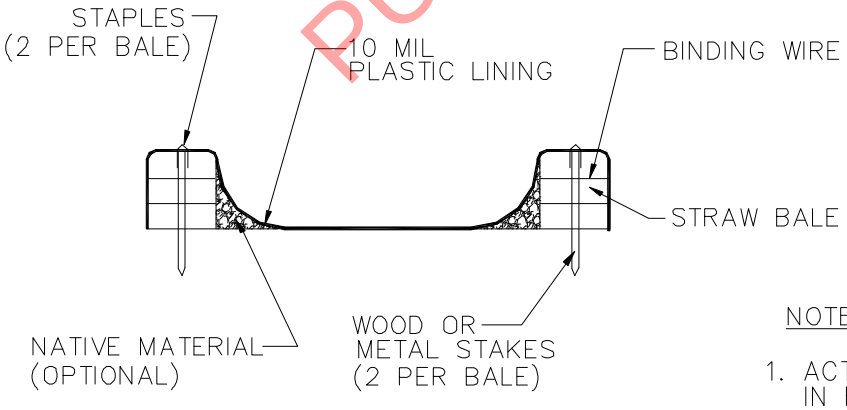
PLAN
NOT TO SCALE
TYPE "ABOVE GRADE"
WITH STRAW BALES



STAPLE DETAIL



CONCRETE WASHOUT
SIGN DETAIL
(OR EQUIVALENT)



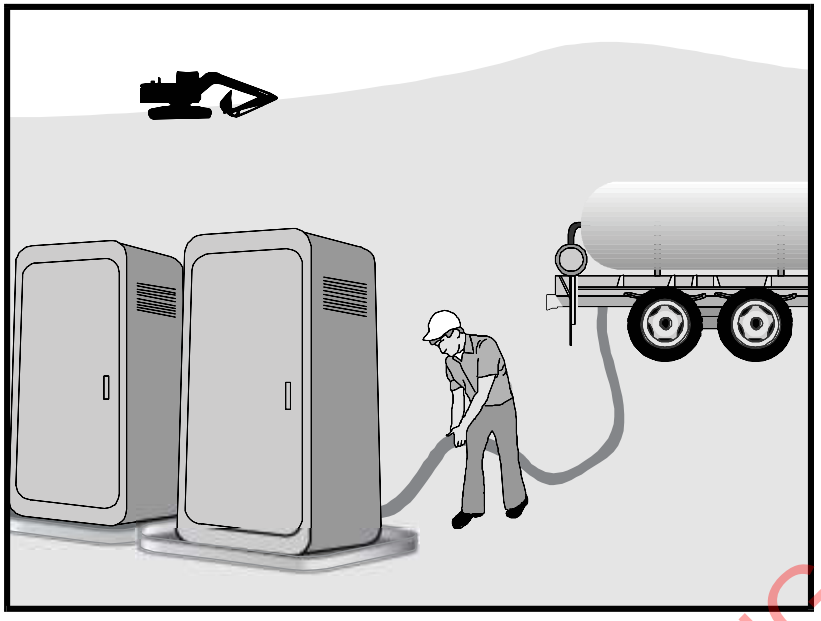
SECTION B–B
NOT TO SCALE

NOTES

1. ACTUAL LAYOUT DETERMINED IN FIELD.
2. THE CONCRETE WASHOUT SIGN SHALL BE INSTALLED WITHIN 30 FT. OF THE TEMPORARY CONCRETE WASHOUT FACILITY.

FOR BIDDING PURPOSES ONLY

Sanitary/Septic Waste Management WM-9



Categories

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 Category**

☒ **Secondary Category**

Description and Purpose

Proper sanitary and septic waste management prevent the discharge of pollutants to stormwater from sanitary and septic waste by providing convenient, well-maintained facilities, and arranging for regular service and disposal.

Suitable Applications

Sanitary septic waste management practices are suitable for use at all construction sites that use temporary or portable sanitary and septic waste systems.

Limitations

None identified.

Implementation

Sanitary or septic wastes should be treated or disposed of in accordance with state and local requirements. In many cases, one contract with a local facility supplier will be all that it takes to make sure sanitary wastes are properly disposed.

Storage and Disposal Procedures

- Temporary sanitary facilities should be located away from drainage facilities, watercourses, and from traffic circulation. If site conditions allow, place portable facilities a minimum of 50 feet from drainage conveyances and traffic areas. When subjected to high winds or risk of high winds, temporary sanitary facilities should be secured to prevent overturning.

Targeted Constituents

Sediment	
Nutrients	☑
Trash	☑
Metals	
Bacteria	☑
Oil and Grease	
Organics	☑

Potential Alternatives

None

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- Temporary sanitary facilities must be equipped with containment to prevent discharge of pollutants to the stormwater drainage system of the receiving water.
- Consider safety as well as environmental implications before placing temporary sanitary facilities.
- Wastewater should not be discharged or buried within the project site.
- Sanitary and septic systems that discharge directly into sanitary sewer systems, where permissible, should comply with the local health agency, city, county, and sewer district requirements.
- Only reputable, licensed sanitary and septic waste haulers should be used.
- Sanitary facilities should be located in a convenient location.
- Temporary septic systems should treat wastes to appropriate levels before discharging.
- If using an onsite disposal system (OSDS), such as a septic system, local health agency requirements must be followed.
- Temporary sanitary facilities that discharge to the sanitary sewer system should be properly connected to avoid illicit discharges.
- Sanitary and septic facilities should be maintained in good working order by a licensed service.
- Regular waste collection by a licensed hauler should be arranged before facilities overflow.
- If a spill does occur from a temporary sanitary facility, follow federal, state and local regulations for containment and clean-up.

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Education

- Educate employees, subcontractors, and suppliers on sanitary and septic waste storage and disposal procedures.
- Educate employees, subcontractors, and suppliers of potential dangers to humans and the environment from sanitary and septic wastes.
- Instruct employees, subcontractors, and suppliers in identification of sanitary and septic waste.
- Hold regular meetings to discuss and reinforce the use of sanitary facilities (incorporate into regular safety meetings).
- Establish a continuing education program to indoctrinate new employees.

Inspection and Maintenance

- BMPs must be inspected in accordance with General Permit requirements for the associated project type and risk level. It is recommended that at a minimum, BMPs be inspected

weekly, prior to forecasted rain events, daily during extended rain events, and after the conclusion of rain events.

- Arrange for regular waste collection.
- If high winds are expected, portable sanitary facilities must be secured with spikes or weighed down to prevent over turning.
- If spills or leaks from sanitary or septic facilities occur that are not contained and discharge from the site, non-visible sampling of site discharge may be required. Refer to the General Permit or to your project specific Construction Site Monitoring Plan to determine if and where sampling is required.

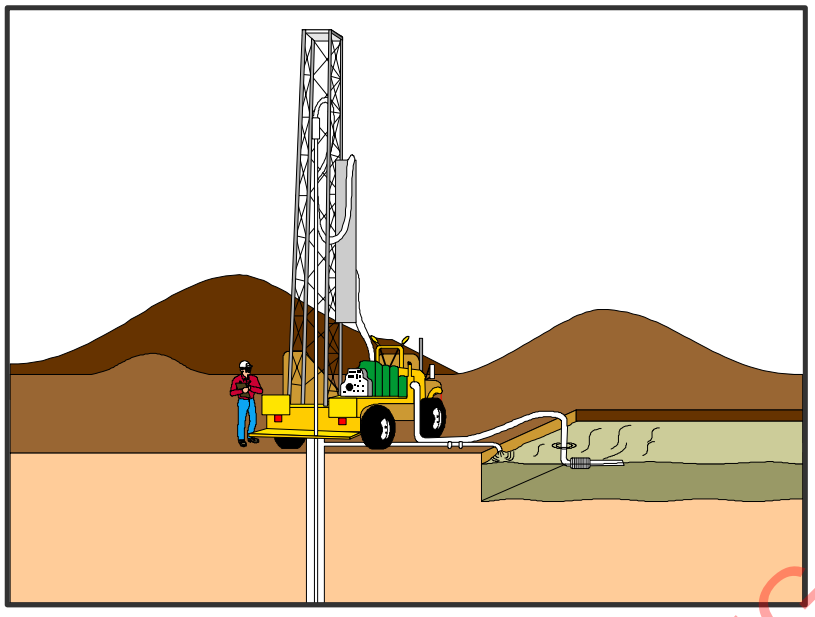
References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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

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Liquid Waste Management WM-10



Categories

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

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Description and Purpose

Liquid waste management includes procedures and practices to prevent discharge of pollutants to the storm drain system or to watercourses as a result of the creation, collection, and disposal of non-hazardous liquid wastes.

Suitable Applications

Liquid waste management is applicable to construction projects that generate any of the following non-hazardous by-products, residuals, or wastes:

- Drilling slurries and drilling fluids
- Grease-free and oil-free wastewater and rinse water
- Dredgings
- Other non-stormwater liquid discharges not permitted by separate permits

Limitations

- Disposal of some liquid wastes may be subject to specific laws and regulations or to requirements of other permits secured for the construction project (e.g., NPDES permits, Army Corps permits, Coastal Commission permits, etc.).

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- Liquid waste management does not apply to dewatering operations (NS-2 Dewatering Operations), solid waste management (WM-5, Solid Waste Management), hazardous wastes (WM-6, Hazardous Waste Management), or concrete slurry residue (WM-8, Concrete Waste Management).

- Typical permitted non-stormwater discharges can include: water line flushing; landscape irrigation; diverted stream flows; rising ground waters; uncontaminated pumped ground water; discharges from potable water sources; foundation drains; irrigation water; springs; water from crawl space pumps; footing drains; lawn watering; flows from riparian habitats and wetlands; and discharges or flows from emergency fire fighting activities.

Implementation

General Practices

- Instruct employees and subcontractors how to safely differentiate between non-hazardous liquid waste and potential or known hazardous liquid waste.

- Instruct employees, subcontractors, and suppliers that it is unacceptable for any liquid waste to enter any storm drainage device, waterway, or receiving water.

- Educate employees and subcontractors on liquid waste generating activities and liquid waste storage and disposal procedures.

- Hold regular meetings to discuss and reinforce disposal procedures (incorporate into regular safety meetings).

- Verify which non-stormwater discharges are permitted by the statewide NPDES permit; different regions might have different requirements not outlined in this permit.

- Apply NS-8, Vehicle and Equipment Cleaning for managing wash water and rinse water from vehicle and equipment cleaning operations.

Containing Liquid Wastes

- Drilling residue and drilling fluids should not be allowed to enter storm drains and watercourses and should be disposed of.

- If an appropriate location is available, drilling residue and drilling fluids that are exempt under Title 23, CCR § 2511(g) may be dried by infiltration and evaporation in a containment facility constructed in conformance with the provisions concerning the Temporary Concrete Washout Facilities detailed in WM-8, Concrete Waste Management.

- Liquid wastes generated as part of an operational procedure, such as water-laden dredged material and drilling mud, should be contained and not allowed to flow into drainage channels or receiving waters prior to treatment.

- Liquid wastes should be contained in a controlled area such as a holding pit, sediment basin, roll-off bin, or portable tank.

- Containment devices must be structurally sound and leak free.

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- Containment devices must be of sufficient quantity or volume to completely contain the liquid wastes generated.
- Precautions should be taken to avoid spills or accidental releases of contained liquid wastes. Apply the education measures and spill response procedures outlined in WM-4, Spill Prevention and Control.
- Containment areas or devices should not be located where accidental release of the contained liquid can threaten health or safety or discharge to water bodies, channels, or storm drains.

Capturing Liquid Wastes

- Capture all liquid wastes that have the potential to affect the storm drainage system (such as wash water and rinse water from cleaning walls or pavement), before they run off a surface.
- Do not allow liquid wastes to flow or discharge uncontrolled. Use temporary dikes or berms to intercept flows and direct them to a containment area or device for capture.
- Use a sediment trap (SE-3, Sediment Trap) for capturing and treating sediment laden liquid waste or capture in a containment device and allow sediment to settle.

Disposing of Liquid Wastes

- A typical method to handle liquid waste is to dewater the contained liquid waste, using procedures such as described in NS-2, Dewatering Operations, and SE-2, Sediment Basin, and dispose of resulting solids per WM-5, Solid Waste Management.
- Methods of disposal for some liquid wastes may be prescribed in Water Quality Reports, NPDES permits, Environmental Impact Reports, 401 or 404 permits, and local agency discharge permits, etc. Review the SWPPP to see if disposal methods are identified.
- Liquid wastes, such as from dredged material, may require testing and certification whether it is hazardous or not before a disposal method can be determined.
- For disposal of hazardous waste, see WM-6, Hazardous Waste Management.
- If necessary, further treat liquid wastes prior to disposal. Treatment may include, though is not limited to, sedimentation, filtration, and chemical neutralization.

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.

FOR BIDDING PURPOSES ONLY

- Remove deposited solids in containment areas and capturing devices as needed and at the completion of the task. Dispose of any solids as described in WM-5, Solid Waste Management.
- Inspect containment areas and capturing devices and repair as needed.

References and Additional Resources

Construction Site Best Management Practices (BMPs) Manual, CTSW-RT-24-425.11.1, California Department of Transportation (Caltrans), March 2024.

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Appendix E: Contractors and Subcontractors

The Contractor assigned to this project is:

Company Name	Contact Name (Site Responsibility)	Address (Street, City, State, Zip)	Phone Number

Subcontractor:

Company Name	Contact Name (Site Responsibility)	Address (Street, City, State, Zip)	Phone Number

Additional Contacts:

Company Name	Contact Name (Site Responsibility)	Address (Street, City, State, Zip)	Phone Number

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Appendix F: Example Sampling Event Forms

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Sampling Field Log Sheets			
Construction Site Name:		Date:	Time Start:
Sampler:			
Sampling Event Type:	☐ Stormwater	☐ Dewatering Discharge	☐ Non-visible pollutant

Field Meter Calibration	
pH Meter ID No./Desc.: Calibration Date/Time:	Turbidity Meter ID No./Desc.: Calibration Date/Time:

Field pH and Turbidity Measurements			
Discharge Location Description	pH	Turbidity	Time

Grab Samples Collected		
Discharge Location Description	Sample Type	Time

Additional Sampling Notes:
Time End:

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CHAIN-OF-CUSTODY **DATE:** **Lab ID:**

DESTINATION LAB: ATTN: **ADDRESS:** **Office Phone:** **Cell Phone:**							REQUESTED ANALYSIS				Notes:	
SAMPLED BY:												
Contact:												
Project Name												
Client Sample ID	**Sample Date**	**Sample Time**	**Sample Matrix**	**Container #**	**Container Type**	**Container Pres.**						

SENDER COMMENTS:

RELINQUISHED BY

Signature:
Print:
Company:
Date: TIME:

LABORATORY COMMENTS:

RECEIVED BY

Signature:
Print:
Company:
Date: TIME:

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Appendix G: Field Meter Instructions

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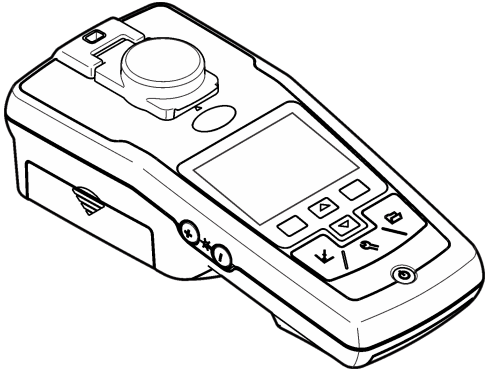
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2100Q and 2100Q*is*

08/2021, Edition 6

User Manual

FOR BIDDING PURPOSES ONLY



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PURPOSES ONLY

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Section 1 Specifications

Specifications are subject to change without notice.

Specification	Details
Measurement method	Ratio turbidimetric determination using a primary nephelometric light scatter signal (90°) to the transmitted light scatter signal.
Regulatory	**2100Q:** Meets EPA Method 180.1
Lamp source	**2100Q:** Tungsten filament lamp **2100Q*is*:** Light-emitting diode (LED)
Range	0–1000 NTU (FNU)
Accuracy	±2% of reading plus stray light from 0–1000 NTU (FNU)
Repeatability	±1% of reading or 0.01 NTU (FNU), whichever is greater
Resolution	0.01 NTU on lowest range
Stray light	≤ 0.02 NTU (FNU)
Signal averaging	Selectable on or off
Detector	Silicon Photodiode
Overvoltage category	II
Altitude	2000 m (6562 ft) maximum
Reading modes	Normal (Push to Read), Signal Averaging or Rapidly Settling Turbidity

Specification	Details
Calibration options	Single step RapidCal for Low-Level Regulatory Reporting from 0–40 NTU (FNU) Full range calibration from 0–1000 NTU (FNU) Calibration to degrees of turbidity
Calibration logger	Records the last 25 successful calibrations
Verification logger	Logs the last 250 successful verifications
Data logger	500 records
Power requirement	Battery powered: 6 VDC maximum (4 NiMH 1.2 V AA batteries or 4 alkaline 1.5 V AA batteries) External power supply: 100–240 VAC ± 10%; output 5 W (9 VDC, 600 mA maximum)
Operating conditions	Temperature: 0 to 50 °C (32 to 122 °F) Relative Humidity: 0–90% at 30 °C, 0–80% at 40 °C, 0–70% at 50 °C, noncondensing
Storage conditions	–40 to 60 °C (–40 to 140 °F), instrument only
Interface	Optional USB
Sample required	15 mL (0.5 oz.)
Sample cells	Round cells 60 x 25 mm (2.36 x 1 in.) borosilicate glass with screw caps
Dimensions	22.9 x 10.7 x 7.7 cm (9.0 x 4.2 x 3.0 in.)
Weight	530 g (1.17 lb) without batteries 620 g (1.37 lb) with four AA alkaline batteries

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Specification	Details
Meter enclosure rating	IP67 (closed lid, battery and module compartment excluded)
Protection class	2100Q/is: Class III Power supply: Class II
Pollution degree	2
Environmental conditions	Indoor and outdoor use
Certification	CE certified
Warranty	1 year (EU: 2 years)

Section 2 General information

In no event will the manufacturer be liable for direct, indirect, special, incidental or consequential damages resulting from any defect or omission in this manual. The manufacturer reserves the right to make changes in this manual and the products it describes at any time, without notice or obligation. Revised editions are found on the manufacturer's website.

2.1 Safety information

The manufacturer is not responsible for any damages due to misapplication or misuse of this product including, without limitation, direct, incidental and consequential damages, and disclaims such damages to the full extent permitted under applicable law. The user is soley responsible to identify critical application risks and install appropriate mechanisms to protect processes during a possible equipment malfunction.

Please read this entire manual before unpacking, setting up or operating this equipment. Pay attention to all danger and caution statements. Failure to do so could result in serious injury to the operator or damage to the equipment.

Make sure that the protection provided by this equipment is not impaired. Do not use or install this equipment in any manner other than that specified in this manual.

2.2 Use of hazard information

⚠ DANGER

Indicates a potentially or imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

Indicates a potentially or imminently hazardous situation which, if not avoided, could result in death or serious injury.

⚠ CAUTION

Indicates a potentially hazardous situation that may result in minor or moderate injury.

NOTICE

Indicates a situation which, if not avoided, may cause damage to the instrument. Information that requires special emphasis.

2.3 Precautionary labels

Read all labels and tags attached to the instrument. Personal injury or damage to the instrument could occur if not observed. A symbol on the instrument is referenced in the manual with a precautionary statement.

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	This is the safety alert symbol. Obey all safety messages that follow this symbol to avoid potential injury. If on the instrument, refer to the instruction manual for operation or safety information.
	This symbol indicates that a risk of electrical shock and/or electrocution exists.
	Electrical equipment marked with this symbol may not be disposed of in European domestic or public disposal systems. Return old or end-of-life equipment to the manufacturer for disposal at no charge to the user.

2.4 Compliance and certification

⚠ CAUTION

This equipment is not intended for use in residential environments and may not provide adequate protection to radio reception in such environments.

Canadian Radio Interference-Causing Equipment Regulation, ICES-003, Class A:

Supporting test records reside with the manufacturer.

This Class A digital apparatus meets all requirements of the Canadian Interference-Causing Equipment Regulations.

Cet appareil numérique de classe A répond à toutes les exigences de la réglementation canadienne sur les équipements provoquant des interférences.

FCC Part 15, Class "A" Limits

Supporting test records reside with the manufacturer. The device complies with Part 15 of the FCC Rules. Operation is subject to the following conditions:

1. The equipment may not cause harmful interference.
2. The equipment must accept any interference received, including interference that may cause undesired operation.

Changes or modifications to this equipment not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment. This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference, in which case the user will be required to correct the interference at their expense. The following techniques can be used to reduce interference problems:

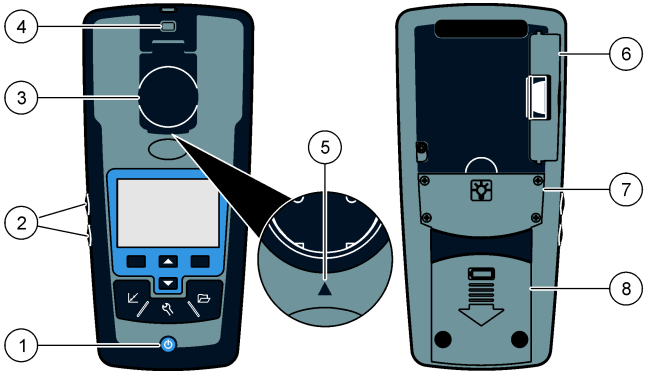
1. Disconnect the equipment from its power source to verify that it is or is not the source of the interference.
2. If the equipment is connected to the same outlet as the device experiencing interference, connect the equipment to a different outlet.
3. Move the equipment away from the device receiving the interference.
4. Reposition the receiving antenna for the device receiving the interference.
5. Try combinations of the above.

2.5 Product overview

The 2100Q and 2100Q*is* portable turbidimeters measure turbidity from 0 to 1000 NTU (FNU). Primarily for field use, the portable meter operates on four AA batteries. Data can be stored and transferred to a printer, computer or USB storage device.

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Figure 1 Product overview

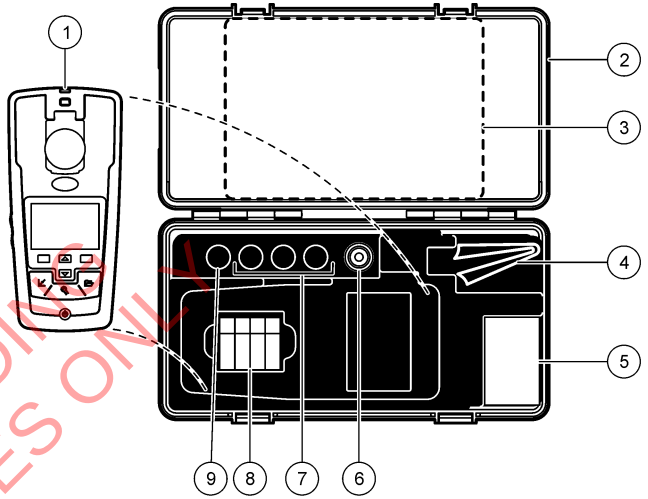


1	Power on or off	**5**	Alignment arrow
2	Backlight keys (+ and -)	**6**	Module
3	Sample cell holder with lid	**7**	Lamp compartment
4	Attachment for lanyard	**8**	Battery compartment

2.6 Product components

Refer to Figure 2 to make sure that all components have been received. If any of these items are missing or damaged, contact the manufacturer or a sales representative immediately.

Figure 2 2100Q and 2100Q*is* components



1	2100Q or 2100Q*is* turbidimeter	**6**	Silicone oil
2	Carrying case	**7**	20, 100 and 800 NTU StablCal calibration standards
3	User manual and Quick reference guide	**8**	AA alkaline batteries (pk/4)
4	Oiling cloth	**9**	StablCal 10 NTU verification standard
5	1" sample cell (10 mL) with cap (pk/6)		

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Section 3 Installation

⚠ CAUTION

Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

3.1 Install the battery

⚠ WARNING

Explosion hazard. An expired battery can cause hydrogen gas buildup inside the instrument. Replace the battery before it expires. Do not store the instrument for long periods with a battery installed.

⚠ WARNING

Potential fire hazard. Use only alkaline or nickel metal hydride batteries (NiMH) in the meter. Other battery types or incorrect installation can cause a fire. Never mix battery types in the meter.

NOTICE

The battery compartment is not waterproof. If the battery compartment becomes wet, remove and dry the batteries and dry the interior of the compartment. Check the battery contacts for corrosion and clean them if necessary.

NOTICE

When using nickel metal hydride (NiMH) batteries, the battery icon will not indicate a full charge after freshly charged batteries have been inserted (NiMH batteries are 1.2 V versus 1.5 V for alkaline batteries). Even though the icon does not indicate complete charge, 2300 mAH NiMH batteries will achieve 90% of instrument operation lifetime (before recharge) versus new alkaline batteries.

NOTICE

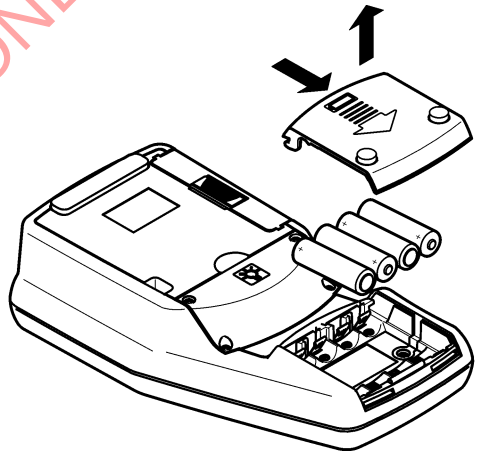
To avoid potential damage to the meter from battery leakage, remove the meter batteries prior to extended periods of non-use.

The meter can be powered with AA alkaline or rechargeable NiMH batteries. To conserve battery life, the meter will power off after 10 minutes of inactivity, the backlight powers off after 30 seconds. This time can be changed in the Power Management menu.
Note: *Rechargeable batteries will only be recharged with the USB/power module. Refer to the module documentation for further information.*

For battery installation refer to Figure 3.

1. Remove the battery cover.
2. Install 4 AA alkaline or 4 AA nickel metal hydride (NiMH) batteries. Make sure that the batteries are installed in the correct orientation.
3. Replace the battery cover.

Figure 3 Battery installation

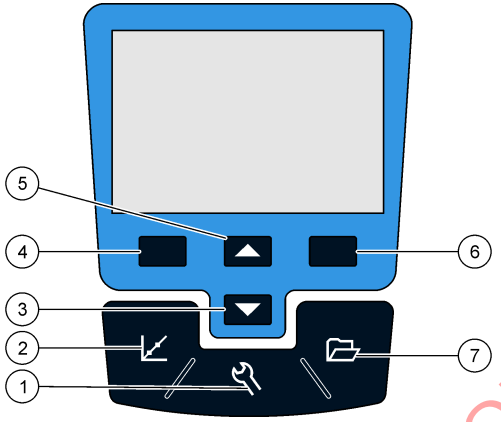


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Section 4 User interface and navigation

4.1 User interface

Figure 4 Keypad description



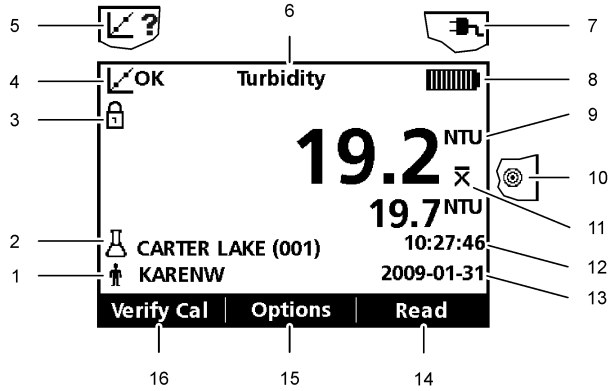
1 **SETTINGS** key: select menu options for setting up the meter	5 **UP** key: scroll through menus, enter numbers and letters
2 **CALIBRATION** key: shows calibration screen, start calibration, select cal options	6 **RIGHT** key (contextual): read turbidity sample, selects or confirms options, opens/jumps to sub-menus
3 **DOWN** key: scroll through menus, enter numbers and letters	7 **DATA MANAGEMENT** key: view, delete or transfer stored data
4 **LEFT** key (contextual): access for calibration verification, cancels or exits the current menu screen to the previous menu screen	

4.2 Display description

The measurement screen shows the turbidity, unit, calibration status, date and time, operator ID (if setup) and sample ID (if setup). Refer to Figure 5.

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Figure 5 Single screen display



1	Operator identification	**9**	NTU (Nephelometric Turbidity Unit) or FNU (Formazin Turbidity Unit)
2	Sample identification	**10**	Reading mode: Rapidly Settling Turbidity (Target icon)
3	Stability or display lock indicator	**11**	Reading mode: Signal Average (X-bar icon)
4	Calibration status indicator (Calibration OK=pass)	**12**	Time
5	Calibration status indicator (Calibration ?=fail)	**13**	Date
6	Parameter title	**14**	Read (contextual: OK, Select)
7	AC power icon	**15**	Options (contextual)
8	Battery icon	**16**	Verification calibration

4.3 Navigation

The meter contains a Settings menu, Reading Options menu, Calibration Options menu and Calibration Verification Options menu to change various options. Use the **UP** and **DOWN** keys to highlight different options. Push the **RIGHT** key to select an option. There are two ways to change options:

1. Select an option from a list: Use the **UP** and **DOWN** keys to select an option. If check boxes are shown, more than one option can be selected. Push the **LEFT** key under Select.

   Note: *To deselect check boxes, push the* ***LEFT*** *key under Deselect.*
2. Enter an option value using the arrow keys:
   Push the **UP** and **DOWN** keys to enter or change a value.
3. Push the **RIGHT** key to advance to the next space.
4. Push the **RIGHT** key under **OK** to accept the value.

Section 5 Startup

5.1 Turn the meter on and off

Push the **ON/OFF** key to turn on or turn off the meter. If the meter does not turn on, make sure that the batteries, or the module, are properly installed or that the AC power supply is properly connected to an electrical outlet.

Note: *The Auto-Shutoff option can also be used to turn off the meter. Refer to* Power management *on page 14.*

5.2 Change the language

There are three options to set the language:

- The display language is selected when the meter is powered on for the first time.
- The display language is selected when the power key is pushed and held.
- The language can be changed from the Settings menu.

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1. Select a language from the list. Confirm with **OK**.
2. Push **Done** when the update is complete.

5.3 Change the date and time

The date and time can be changed from the Date & Time menu.

1. Push the **SETTINGS** key and select Date & Time.
2. Update the time and date information:

Option	Description
Format	Select one of the formats for the date and time: yyyy-mm-dd 24h yyyy-mm-dd 12h dd-mm-yyyy 24h dd-mm-yyyy 12h mm/dd/yyyy 24h mm/dd/yyyy 12h
Date	Enter the current date
Time	Enter the current time

The current date and time will be shown on the display.

After the date and time setup, the meter is ready to take a reading.

Section 6 Standard operation

6.1 Use a sample ID

The sample ID tag is used to associate readings with a particular sample location. If assigned, stored data will include this ID.

1. Select **Sample ID** in the Settings menu.
2. Select, create or delete a sample ID:

Option	Description
Current ID	Select an ID from a list. The current ID will be associated with sample data until a different ID is selected.
Create a New Sample ID	Enter a name for a new sample ID.
Delete Sample ID	Delete an existing sample ID.

6.2 Use an operator ID

The operator ID tag associates readings with an individual operator. All stored data will include this ID.

1. Select **Operator ID** in the Settings menu.
2. Select, create or delete an operator ID:

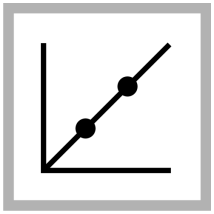
Option	Description
Current ID	Select an ID from a list. The current ID will be associated with sample data until a different ID is selected.
Create a New Operator ID	Enter a name for a new operator ID (maximum 10 names can be entered).
Delete Operator ID	Delete an existing operator ID.

6.3 Calibrate the turbidimeter with StablCal Standards

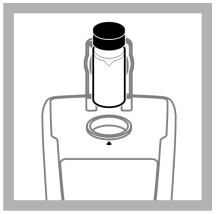
Note: *For best accuracy use the same sample cell or four matched sample cells for all readings during calibration. Insert the sample cell in the instrument cell*

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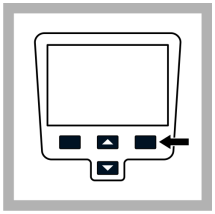
compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment.



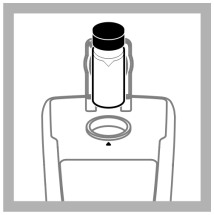
1. Push the **CALIBRATION** key to enter the Calibration mode. Follow the instructions on the display.
Note: *Gently invert each standard before inserting the standard.*



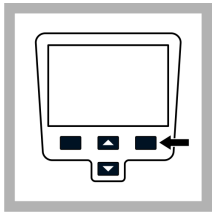
2. Insert the 20 NTU StablCal Standard and close the lid.
Note: *The standard to be inserted is bordered.*



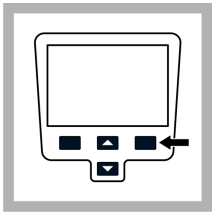
3. Push **Read**. The display shows Stabilizing and then shows the result.



4. Repeat Step 2 and 3 with the 100 NTU and 800 NTU StablCal Standard.
Note: *Push **Done** to complete a 2 point calibration.*



5. Push **Done** to review the calibration details.



6. Push **Store** to save the results. After a calibration is complete, the meter automatically goes into the Verify Cal mode. Refer to Calibration verification (Verify Cal) on page 19.

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6.4 Turbidity measurement

⚠WARNING

Potential explosion and fire hazard. This turbidimeter is designed for water based samples. Do not measure solvent or combustible based samples.

Readings can be taken with the Normal reading mode, Signal Average mode or in the Rapidly Settling Turbidity mode. Refer to Reading modes on page 20 for more information. For accurate turbidity readings use clean sample cells and remove air bubbles (degassing).

6.4.1 Measurement notes

Proper measurement techniques are important in minimizing the effects of instrument variation, stray light and air bubbles. Use the following measurement notes for proper measurements.

Instrument

- Make sure that the meter is placed on a level, stationary surface during the measurement.
  Note: *Do not hold the meter in the hand during measurement.*
- Always close the sample compartment lid during measurement, calibration and storage.
- Remove sample cell and batteries from the instrument if the instrument is stored for an extended time period (more than a month).
- Keep the sample compartment lid closed to prevent the entry of dust and dirt.

Sample cells

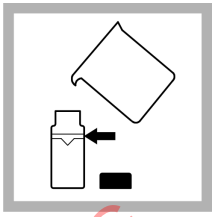
- Always cap the sample cell to prevent spillage of the sample into the instrument.
- Always use clean sample cells in good condition. Dirty, scratched or damaged cells can cause inaccurate readings.
- Make sure that cold samples do not “fog” the sample cell.
- Store sample cells filled with distilled or deionized water and cap tightly.

Measurement

- Measure samples immediately to prevent temperature changes and settling. Before a measurement is taken, always make sure that the sample is homogeneous throughout.
- Avoid sample dilution when possible.
- Avoid operation in direct sunlight.

6.4.2 Turbidity measurement procedure

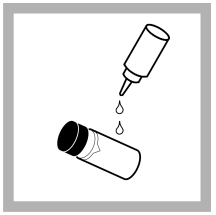
Note: *Before a measurement is taken, always make sure that the sample is homogeneous throughout.*



1. Collect a representative sample in a clean container. Fill a sample cell to the line (about 15 mL). Take care to handle the sample cell by the top. Cap the cell.



2. Wipe the cell with a soft, lint-free cloth to remove water spots and fingerprints.



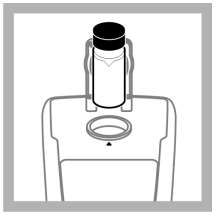
3. Apply a thin film of silicone oil. Wipe with a soft cloth to obtain an even film over the entire surface (Apply silicone oil to a sample cell on page 20).

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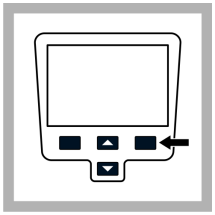


4. Push the **Power** key to turn the meter on. Place the instrument on a flat, sturdy surface.

Note: *Do not hold the instrument while making measurements.*



5. Gently invert and then insert the sample cell in the instrument cell compartment so the diamond or orientation mark aligns with the raised orientation mark in front of the cell compartment. Close the lid.



6. Push **Read**. The display shows Stabilizing then the turbidity in NTU (FNU). The result is shown and stored automatically. Additional information is available on the manufacturer's website.

Section 7 Data management

7.1 About stored data

The following types of data are stored in the data log:

- Reading Log: stores automatically each time a sample reading is taken (500 records).
- Calibration Log: stores only when **Store** is selected at the end of a calibration (25 records).
- Verify Cal Log: stores only after **Done** is selected at the end of a verification calibration (250 records).

When the data log becomes full, the oldest data point is deleted when more data is added to the log.

7.2 View data log

The data log contains Reading Log, Calibration Log and Verify Cal log. All logs can be sorted by date.

1. Push the **DATA MANAGEMENT** key.
2. Select View Data Log to view the stored data.
3. Push **Select** to view additional information.

Option	Description
Reading Log	Reading Log—shows the date, time and reading mode and associated calibration data.
Calibration Log	Calibration Log—shows the date and time of calibration data and additional information about the calibration.
Verify Cal Log	Verify Cal Log—shows the calibration verification date and time and additional information about the verification.
All Logs by Date	The most recent data and additional information is shown. The icons show whether the data is from a reading, calibration or calibration verification and identifies the reading mode, if applicable.

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7.3 Delete data log

There are two possibilities to delete stored readings in the Data Management menu:

1. Push the **DATA MANAGEMENT** key and select Delete Data Log.

Option	Description
Delete Last Reading	Only the last reading stored can be deleted until a new reading is taken and stored.
Delete All Logs	The entire Reading Log can be deleted at once.

7.4 Send stored data

Data can be stored and transferred to a printer, computer or USB storage device. The data will be formatted as an XML file. Install the USB/power module to the meter and to AC power. Refer to the module documentation for more information.

Section 8 Advanced operation

8.1 Display contrast

1. Push the **SETTINGS** key and select Display Contrast.
2. Use the **UP** and **DOWN** key to adjust the contrast of the display and push OK.

8.2 Power management

Use power management to change the backlight option and the battery saving auto-shutoff option.
Note: *Power management is not active when the meter is connected to AC power.*

1. Push the **SETTINGS** key and select Power Management.
2. Select which display option to change.

Option	Description
Backlight	The display is illuminated. To maximize battery life, select a time period after which the backlight will automatically power off if no key is pushed: 10 s, 20 s, 30 s,1 min, 2 min, 5 min ***Note:*** *The Backlight keys (Figure 1 on page 6) will turn the backlight on and off.*
Auto-Shutoff	To maximize battery life, set a time period after which the meter will automatically power off if no key is pushed: 1 min, 2 min, 5 min, 10 min, 30 min, 1 h

8.3 Set the sound options

The meter can make an audible sound when a key is pushed, when a reading is complete or when the calibration reminder is due.

1. Push **SETTINGS** and select Sounds.
2. Select which events will produce an audible sound. Multiple items can be selected.

Option	Description
Key Press	The meter will make an audible sound whenever a key is pushed.
Reading complete	The meter will make an audible sound whenever a reading is completed.
Reminders	The meter will make an audible sound when a calibration is due.

8.4 Security options

The Security Options menu is used to protect the meter setup.

The Setup Date and Time, Delete Data Log, Restoring Factory Defaults and Restore Factory Cal screens are not accessible without a password.

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Store the password in a safe and accessible place. If the specified password is forgotten and Security Options is turned on, the operator is locked out of the restricted menus. Contact technical support if the password is lost.

8.4.1 Turn security options on

The security options and the set password options are used together to prevent access to restricted menus.

1. Push the **SETTINGS** key and select Security Options.
2. Select Edit Password and use the **UP** and **DOWN** keys to set a password.
3. Select Security On to enable the password setting. The requirement for the password entry is controlled by setting Security Options on or off.
   Note: *Set the Security to Off to disable the password setting.*
4. Push the **ON/OFF** key to turn off and on the meter to activate the password settings.

8.5 View meter information

The instrument information menu shows specific information such as the meter name, model number, software version, serial number and available Operator and Sample IDs. 10 Operator IDs and 100 Sample IDs are available.

1. Push the **SETTINGS** key and select Meter Information.

8.6 Calibration

The portable turbidimeter is calibrated with Formazin Primary Standards at the factory. The meter should be calibrated upon receipt for best results. The manufacturer recommends calibration with a primary standard such as StablCal Stabilized Standards or with formazin standards every three months.
Note: *Set* ***Cal Reminder Repeat*** *in the Calibration Options menu for periodical calibration. Verify the calibration once a week.*

8.6.1 Calibration options

The calibration options contain Calibration History, Calibration Curves, Cal Reminder Repeat and Restore Factory Calibration.

1. Push the **CALIBRATION** key and then the **UP**and **DOWN** key.

Option	Description
Calibration History	The calibration history shows a list of the times when the meter was calibrated. Select a date and time to view a summary of the calibration data.
Cal.Curve	Select one of the calibration curves for calibration: StablCal RapidCal (0–40 NTU) StablCal (0–1000 NTU) Formazin RapidCal (0–40 NTU) Formazin (0–1000 NTU) Degrees (0–100 mg/L) SDVB (0–1000 NTU) Custom (0–1000 NTU)
Cal Reminder Repeat	The meter will make an audible sound when calibration is due. Select one of the following options for time interval and push OK: Off, 1 d, 7 d, 30 d, 60 d, 90 d
Restore Factory Calibration	All user calibrations will be deleted. The original factory calibration is restored.

8.6.2 Calibration standard overview

Refer to Table 1 for the calibration standard overview.

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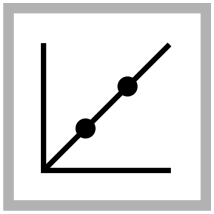
Table 1 Calibration overview

Type of calibration	Required standards			
StablCal RapidCal (0–40 NTU)	–	20 NTU	–	–
StablCal (0–1000 NTU)	–	20 NTU	100 NTU	800 NTU
Formazin RapidCal (0–40 NTU)	Typically deionized or distilled water[1]	20 NTU	–	–
Formazin (0–1000 NTU)	Typically deionized or distilled water[1]	20 NTU	100 NTU	800 NTU
Degrees (0–100 mg/L)	Typically deionized or distilled water[1]	20 NTU	100 NTU	–
SDVB (0–1000 NTU)	Typically deionized or distilled water[1]	20 NTU	100 NTU	800 NTU
Custom (0–1000 NTU)	Typically deionized or distilled water[1]	Select values		

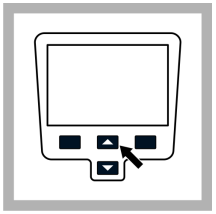
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[1] The water must have a turbidity <0.5 NTU to prepare the calibration standards.

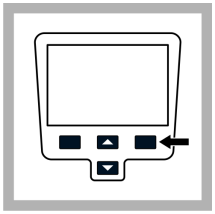
8.6.3 StablCal RapidCal calibration



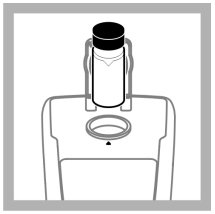
1. Push the **CALIBRATION** key to enter the Calibration mode. Follow the instructions on the display.
Note: *Gently invert each standard before inserting the standard.*



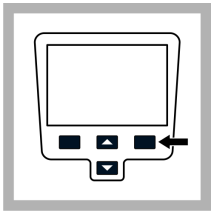
2. Push the **UP** and **DOWN** key to access Cal Options and then select Cal.Curve.



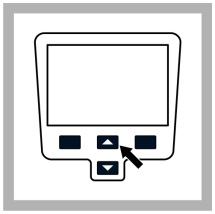
3. Select StablCal RapidCal from the list and push **OK**.



4. Insert the 20 NTU StablCal Standard and close the lid.
Note: *The standard to be inserted is bordered.*

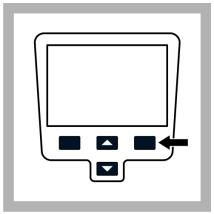


5. Push **Read**. The display shows Stabilizing and then shows the result.



6. Push **Done** to review the calibration details.

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7. Push **Store** to save the results. After a calibration is complete, the meter automatically goes into the Verify Cal mode, refer to Calibration verification (Verify Cal) on page 19.

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8.6.4 Verification options

The Verification Options contain: Set Verification Standard, Set Acceptance Criteria and Verification Reminder.

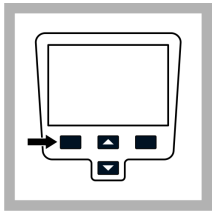
1. Push the **Left** key (Verify Cal) and then the **UP** and **DOWN** keys.

Option	Description
Set Verification Standard	To change the verification standard use the **UP** and **DOWN** keys to enter a new standard value. Range 0.50–20.0 NTU (Default setting: 10.00 NTU) Range 0–20 NTU for RapidCal (0–40 NTU) 0–800 NTU for calibration curves with a range from 0–1000 NTU
Set Acceptance Criteria	Enter the Acceptance Criteria for comparison against the initial calibration verification reading to determine passing or failing. Range 1–50% (Default setting: 10%)
Verification Reminder	Verification Reminder—The meter will make an audible sound when verification is due. Select one of the following options for time interval and push **OK**:Off, 30 min (Default setting), 2 h, 4 h, 8 h, 24 h Allow Defer—Push **Allow Defer** and select Yes or No to postpone the verification due time

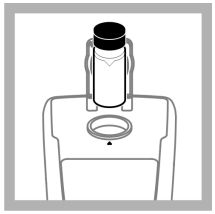
8.6.5 Calibration verification (Verify Cal)

The manufacturer recommends a calibration verification once a week. After a calibration is complete, the meter automatically goes into the Verify Cal mode.

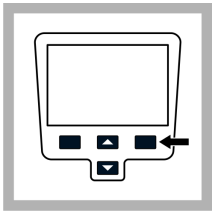
Make sure that the sample cell is clean. Oil the sample cell with silicone oil, refer to Apply silicone oil to a sample cell on page 20. Check the standard solution. Prepare a formazin standard at the same value and read the value.



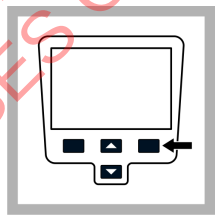
1. Push **Verify Cal** to enter the Verify menu.



2. Gently invert the standard. Insert the 10.0 NTU (or other defined value) Verification Standard and close the lid.



3. Push **Read**. The display shows Stabilizing and then shows the result and tolerance range.



4. Push **Done** to return to the reading display. Repeat the calibration verification if the verification failed.

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8.7 Reading modes

1. Push the **UP** or **DOWN** key to enter the Reading Options menu.
2. Select Reading Mode to select one of the following options:

Option	Description
Normal (Default setting)	The normal mode reads and averages three readings. The result is shown after the reading.
Signal Average 	The Signal Average mode compensates for reading fluctuations caused by drifting of sample particles through the light path. The X-bar icon is shown on the display when signal averaging is on. The Signal Average mode measures 12 times and starts to show the average after three readings. The final result is the average of all 12 readings.
Rapidly Settling Turbidity (RST) 	The Rapidly Settling Turbidity (RST) mode calculates and continuously updates the turbidity reading of the sample to a confidence of 95%, based on the accumulated trend of the real time measured values. The RST mode is best used on samples that settle rapidly and continuously change in value. The reading is based on a correctly prepared sample that is homogeneous at the beginning of the reading. It is best applied to samples that are greater than 20 NTU. The sample must be mixed thoroughly by inversion immediately before inserting it into the meter. The target icon is shown on the display when the Rapidly Settling Turbidity is on. The Rapidly Settling Turbidity reads and calculates five readings while showing intermediate results.

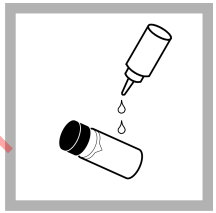
8.8 Apply silicone oil to a sample cell

Sample cells and caps must be extremely clean and free from significant scratches. Apply a thin coating of silicone oil on the outside of the sample cells to mask minor imperfections and scratches that may contribute to light scattering.

Note: *Use only the provided silicone oil. This silicone oil has the same refractive index as the sample cell glass.*



1. Clean the inside and outside of the cells and caps by washing with a laboratory glass cleaning detergent. Follow with multiple rinses with distilled or demineralized water.



2. Apply a small bead of silicone oil from the top to the bottom of the cell.



3. Use the provided oiling cloth to spread the oil uniformly. Wipe off the excess so that only a thin coat of oil is left. Make sure that the sample cell is almost dry with little or no visible oil.

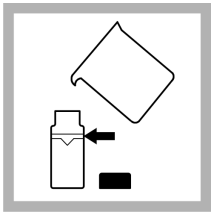
Note: *Store the oiling cloth in a plastic storage bag to keep the cloth clean.*

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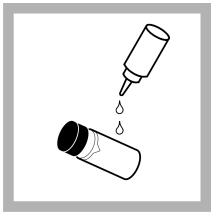
8.9 Indexing a single cell

Precise measurements for very low turbidity samples require the use of a single cell for all measurements or optically matching the cells. Use one cell to provide the best precision and repeatability. When one cell is used, an index or orientation mark (other than the factory-placed diamond) can be placed on the cell so it is inserted into the instrument with the same orientation each time.
When using a single cell, make an index or orientation mark on the cell as follows:

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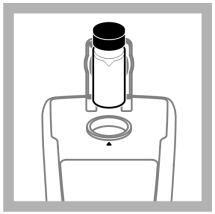
1. Fill the clean sample cell to the line with high quality water (< 0.5 NTU) and cap immediately. Let the sample cell degas for at least five minutes.



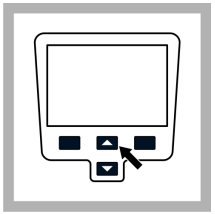
2. Wipe with lint-free cloth. Apply a thin film of silicone oil (Apply silicone oil to a sample cell on page 20).



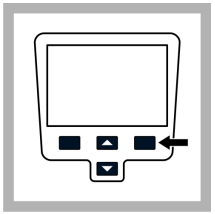
3. Push the **POWER** key to turn the meter on. Place the instrument on a flat, sturdy surface. ***Note:*** *Do not hold the instrument while making measurements.*



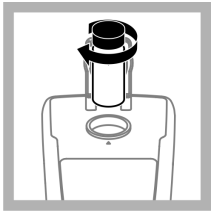
4. Insert the sample cell in the instrument cell compartment so the diamond or orientation mark always aligns with the raised orientation mark in front of the cell compartment. Close the lid.



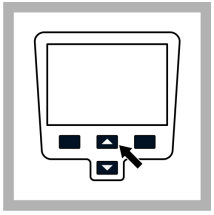
5. Push the **UP** and **DOWN** key to access the Reading Options and then select Indexing Sample Cell. ***Note:*** *The instruments always stays in the last selected reading mode.*



6. Push **Read**. The display shows Stabilizing then the turbidity in NTU. Record the cell position in the cell compartment and the reading result.



7. Remove the cell, rotate it slightly approximately ⅛ of a turn and insert it again into the cell compartment. Close the lid.



8. Push **Read**. Record the cell position in the cell compartment and the reading result.



9. Repeat step 6 until the lowest reading is shown. Place an orientation mark on the cell marking band near the top of the cell so the cell can be consistently inserted in the position that yields the lowest reading.

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Section 9 Maintenance

⚠ CAUTION



Multiple hazards. Only qualified personnel must conduct the tasks described in this section of the document.

9.1 Clean the meter

The meter is designed to be maintenance-free and does not require regular cleaning for normal operation. Exterior surfaces of the meter may be cleaned as necessary.

Note: *Do not clean the meter with solvents to avoid damaging the material.*

1. Clean the meter with a dust- and lint-free dry or slightly damp cloth. A mild soap solution can also be used for liposoluble contamination.

9.2 Store the sample cells

NOTICE

Do not air dry the sample cells.

Note: *Always store the sample cells with caps on to prevent the cells from drying.*

1. Fill the sample cells with distilled or demineralized water.
2. Cap and store the sample cells.
3. Wipe the outside of the sample cells dry with the a soft cloth.

9.3 Replace the battery

⚠ WARNING



Explosion hazard. An expired battery can cause hydrogen gas buildup inside the instrument. Replace the battery before it expires. Do not store the instrument for long periods with a battery installed.

⚠ WARNING

Potential fire hazard. Use only alkaline or nickel metal hydride batteries (NiMH) in the meter. Other battery types or incorrect installation can cause a fire. Never mix battery types in the meter.

For battery replacement refer to Install the battery on page 7.

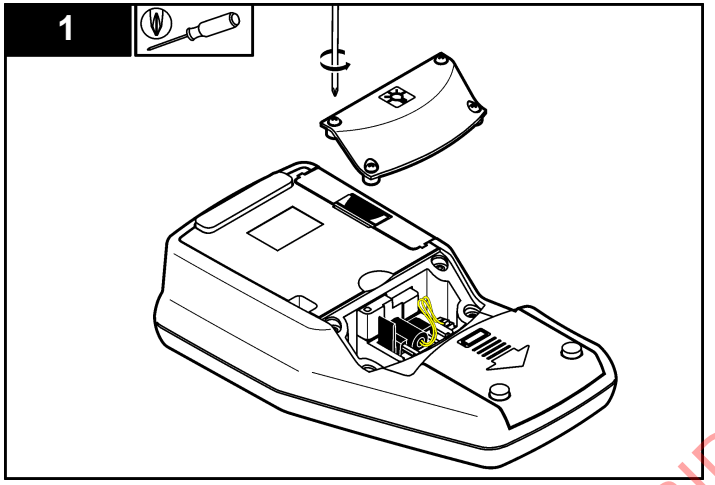
1. Remove the battery cover.
2. Remove the batteries.
3. Install 4 AA alkaline or 4 AA nickel metal hydride (NiMH) batteries. Make sure that the batteries are installed in the correct orientation.
4. Replace the battery cover.

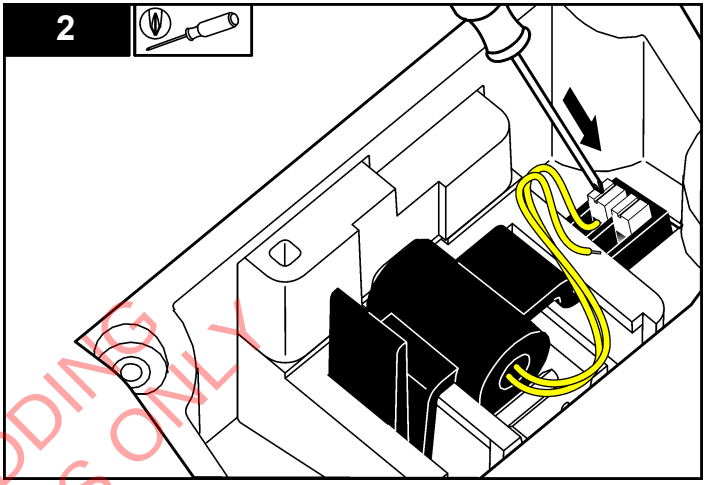
9.4 Replace the lamp

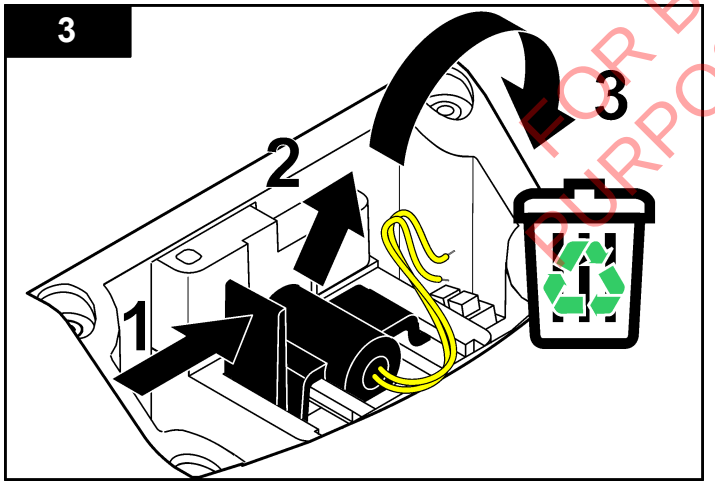
⚠ CAUTION

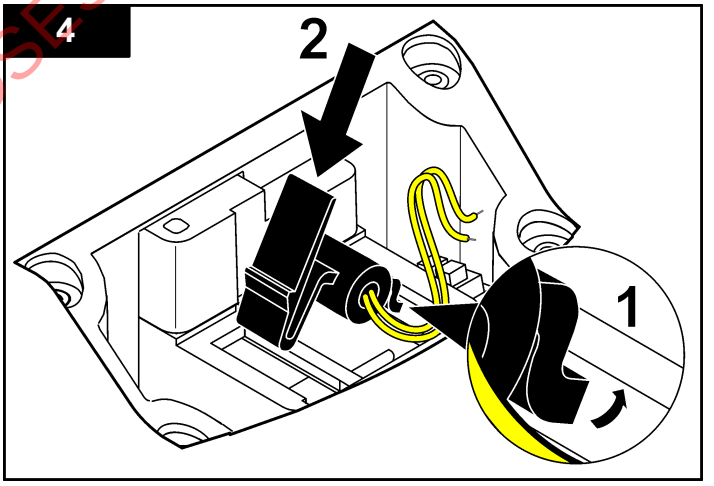
Burn Hazard. Wait until lamp cools down. Contact with the hot lamp can cause burns.

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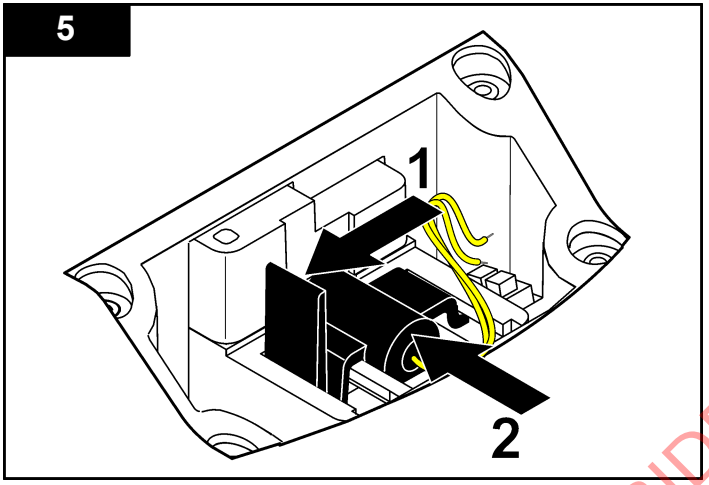


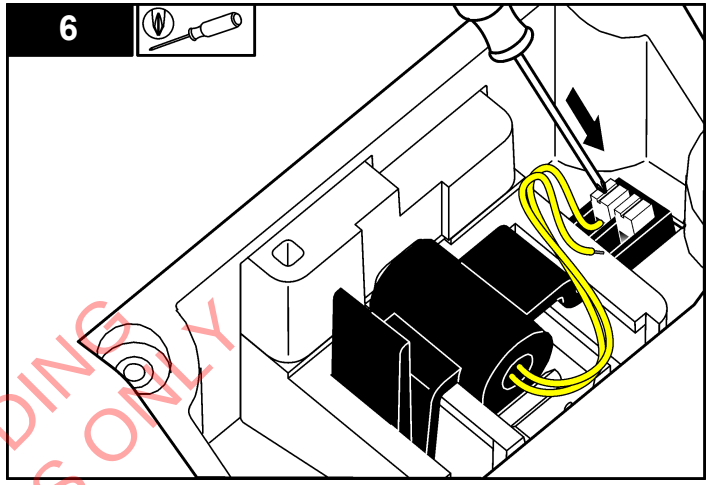


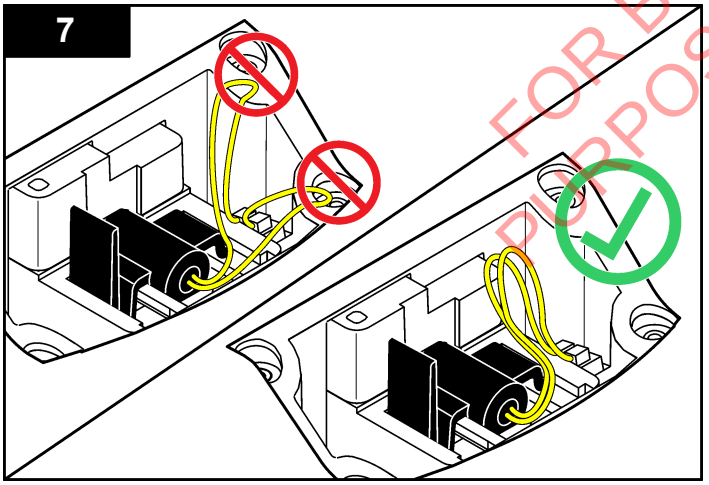


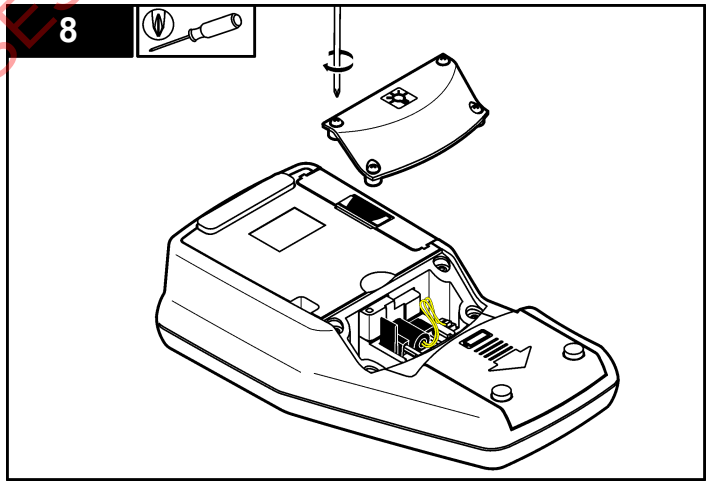


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Section 10 Troubleshooting

Refer to the following table for common problem messages or symptoms, possible causes and corrective actions.

Error/Warning	Description	Solution
Close lid and push Read.	The lid is open or lid detection failed.	Make sure that the lid is closed during reading and re-read.
Low Battery!	Battery is low.	• Insert new batteries • Connect USB/power module if rechargeable batteries are used
ADC Failure!	Hardware error causing reading to fail.	Repeat the reading.
Detector signal too low!	Insufficient light on the 180° detector.	• Check for obstructed light path. • Check the lamp.
Overrange!	Turbidity too high-caused probably by calibrating with RapidCal only.	• Calibrate the upper range. • Dilute the sample.
Underrange!	The measured absorbance is below the calibration range.	Repeat calibration
Please check the lamp!	Signals are too low on the 90° and 180° detector.	**2100Q:** The lamp is defective. Change the lamp (refer to Replace the lamp on page 23). **2100Q*is*:** Contact technical support.
Temperature too high! Switch off instrument.	Temperature has exceeded the meter limits (>60 °C or >140 °F).	Turn off the meter and let it cool down.
RST: Average value!	Solids are settling too slowly. The reading mode is not suitable for this sample.	Select Normal or Signal Average reading mode.
Confidence level is < 95%	The reading mode Rapidly Settling Turbidity did not meet the range of ≥ 95% confidence.	• Invert the sample several times so that the solids allocate. Repeat the reading again. • Switch to the Normal reading mode if the sample is stable and does not have settable solids.
Standard value out of range. Insert standard and push Read	Used incorrect standard value for the reading.	Insert the appropriate standard and read again.
ID already in use. Enter new ID	The Operator or Sample ID is unavailable as it is already assigned.	Create a new ID.

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Error/Warning	Description	Solution
Error - Security Please set password before activating security	No password is created.	Create a new password.
Please enter at least one character.	Password must contain minimum of one character.	Create a password of at least one character.
Password incorrect. Please retry.	Incorrect password was entered.	Enter the appropriate password.
Please disconnect the USB cable from your computer.	Data storage does not respond while connected to the meter and the computer.	Disconnect the USB cable from the meter and try sending data again.
USB module memory full. Delete data and try again.	Data storage is full.	**1.** Connect USB/power module to the computer. **2.** Download the stored data to the computer. **3.** Delete Data Log on the module.

Error/Warning	Description	Solution
Delete Last Reading Failed!	Error in the data storage.	Turn the meter off and on. If the error message still occurs, contact technical support.
Delete Data Log failed!		
Can't read data set!		
Can't store data!		
Can't store to the Reading Log!		
Can't store to the Verify Cal Log!		
Error storing data!		
Error reading data!		

FOR BIDDING PURPOSES ONLY

Section 11 Replacement parts and accessories

11.1 Replacement parts

Description	Quantity	Item no.
StablCal ampule calibration kit	1	2971205
10 NTU verification standard	100 mL	2961701
Silicone Oil	15 mL	126936
Insert, molded bottom	1	2971507
Sample cell oiling cloth	1	4707600
1" glass sample cell (10 ml) w/cap (Turb)	pkg/6	2434706
Carrying case (includes insert)	1	2971500

11.1 Replacement parts (continued)

Description	Quantity	Item no.
Battery set, AA alkaline batteries	pkg/4	1938004
Lamp assy	1	4653900
Blank module	1	LZV797
Rubber foot set	1	LZV821
Lamp cover (includes screws)	1	LZV822
Battery cover (includes 2 feet)	1	LZV823
Module cover	1	LZV824
Connector cover for USB/power module	1	LZV825
Connector cover for power module	1	LZV826
Lid (includes magnet)	1	LZV827

11.2 Accessories

Description	Quantity	Item no.
USB/power module (includes: universal power supply, USB cable, instruction sheet)	1	LZV813.99.00001[2]
Power module (includes: universal power supply, instruction sheet)	1	LZV804.99.00001[1]
USB module with USB cable (2x)	1	LZV949.99.00001[1]
StablCal 0.1 NTU Standard	100 mL	2723342

11.2 Accessories (continued)

Description	Quantity	Item no.
StablCal 0.3 NTU Standard	100 mL	2697943
StablCal 0.5 NTU Standard	100 mL	2698042
StablCal calibration kit	100 mL	2971210
StablCal calibration kit	500 mL	2971200
Gelex secondary standards set	1	2464105
Deionized water	4 vials	27217
Filter	0.2 micron	2323810
Formazin	500 ml	246149
Formazin	1000 ml	246142
Sample degassing kit	1	4397500
Sample degassing and filtration kit	1	4397510
Battery, NiMH AA	pk/4	2971304

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[2] Not available in all regions

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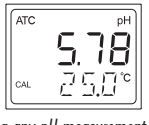
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Exiting Calibration

- When in calibration mode, it is possible to exit calibration procedure by pressing ⏻/MODE, before first-point calibration has been accepted. The tester displays "ESC" and returns to measurement mode and last calibrated data.
- When in calibration mode, it is possible to clear a previous calibration and return to default values by pressing SET/HOLD, before the first calibration point has been accepted. The tester displays "CLR" on the second LCD line, "CAL" tag dissappears and tester returns to default calibration.

Measurement

Use SET/HOLD to select pH mode. Place the electrode in the solution to be tested while stirring gently. The measurement should be taken after the stability tag (⏱) has disappeared. The pH value is displayed on the first LCD line and the temperature on the second LCD line.



Note: *Before taking any pH measurement make sure the tester has been calibrated ("CAL" tag is displayed).*

Maintenance

Please read the information below to ensure the highest possible accuracy.

- Fresh buffer solution should be used for each calibration.
- For improved accuracy a two- or (HI98128 only) three-point calibration is recommended.
- If measurements are taken successively, rinse the probe thoroughly in distilled or deionized water to eliminate cross-contamination.
- Clean the electrode monthly by keeping the electrode in HI7061 General purpose cleaning solution for 30 minutes and rinsing the probe thoroughly with water.
- When not in use, add a few drops of HI70300 Storage solution to the protective cap. Never store the probe in distilled or deionized water.

Electrode Replacement

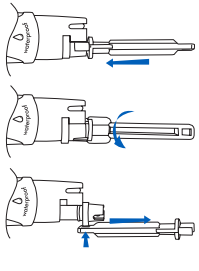
Use supplied removal tool (HI73128) to replace the pH electrode.

Insert the tool into the electrode cavity.

Rotate the tool counterclockwise.

Pull the electrode out by using the other side of the tool.

Insert a new pH electrode following the above instructions in reverse order.



Battery Replacement

Battery life percentage indicator is displayed at power on. If the battery level drops below 5%, the ▭ symbol lights up indicating that the batteries should be replaced soon.
If the battery level is not adequate to guarantee an accurate reading, the tester automatically turns off.
To replace the batteries, follow the next steps:

1. Turn OFF the tester.
2. Remove the four screws on the top of the tester to open the battery compartment (figure 1).
3. Remove the old batteries.
4. Insert four new 1.5V AA batteries in the battery compartment while paying attention to the correct polarity (figure 2).
5. Close the battery compartment using the four screws.

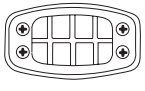
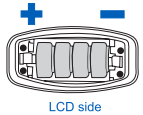
fig. 1 

fig. 2 

Note: *Only use the battery type specified in the manual. Old batteries should be disposed in accordance with local regulations.*

Accessories

Electrode	
HI73127	Replaceable pH electrode
HI73128	Electrode removal tool
pH Buffer Solution	
HI70004P	pH 4.01 solution, 20 mL sachet (25 pcs.)
HI70006P	pH 6.86 solution, 20 mL sachet (25 pcs.)
HI70007P	pH 7.01 solution, 20 mL sachet (25 pcs.)
HI70009P	pH 9.18 solution, 20 mL sachet (25 pcs.)
HI70010P	pH 10.01 solution, 20 mL sachet (25 pcs.)
HI770710P	pH 10.01 & 7.01 solution, 20 mL sachet (10 pcs., 5 each)
HI77400P	pH 4.01 & 7.01 solutions, 20 mL sachet (10 pcs., 5 each)
Electrode Cleaning Solution	
HI7061M	Electrode cleaning solution, 230 mL
Electrode Storage Solution	
HI70300M	Electrode storage solution, 230 mL
Other Accessories	
HI740026P	Replacement 1.5V batteries (12 pcs.)

Certification

All Hanna Instruments conform to the **CE European Directives.**

CE RoHS compliant

Disposal of Electrical & Electronic Equipment. The product should not be treated as household waste. Instead hand it over to the appropriate collection point for the recycling of electrical and electronic equipment which will conserve natural resources.

Disposal of waste batteries. This product contains batteries, do not dispose of them with other household waste. Hand them over to the appropriate collection point for recycling.
Ensuring proper product and battery disposal prevents potential negative consequences for the environment and human health. For more information, contact your city, your local household waste disposal service, the place of purchase or go to www.hannainst.com.

Recommendations for Users

Before using these testers, make sure that they are entirely suitable for your specific application and for the environment in which they are used. Any variation introduced by the user to the supplied equipment may degrade the tester's performance. Avoid touching the electrode at all times. For yours and the tester's safety do not use or store the tester in hazardous environments.

Warranty

HI98127 and HI98128 are warranted for a period of one year against defects in workmanship and materials when used for their intended purpose and maintained according to instructions. The electrode is warranted for a period of six months. This warranty is limited to repair or replacement free of charge. Damage due to accidents, misuse, tampering or lack of prescribed maintenance is not covered. If service is required, contact your local Hanna Instruments Office. If under warranty, report the model number, date of purchase, serial number and the nature of the problem. If the repair is not covered by the warranty, you will be notified of the charges incurred. If the instrument is to be returned to Hanna Instruments Office, first obtain a Returned Goods Authorization (RGA) number from the Technical Service department and then send it with shipping costs prepaid. When shipping any instrument, make sure it is properly packaged for complete protection.

Hanna Instruments reserves the right to modify the design, construction, or appearance of its products without advance notice.

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US DESIGN PATENT D462,024

IST98127 06/20

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INSTRUCTION MANUAL

HI98127 • HI98128

Waterproof pH Testers



HANNA® instruments

Dear Customer,

Thank you for choosing a Hanna Instruments product. Please read this instruction manual carefully before using the tester. For more information about Hanna Instruments and our products, visit www.hannainst.com or e-mail us at sales@hannainst.com.
For technical support, contact your local Hanna Instruments Office or e-mail us at tech@hannainst.com.

Preliminary Examination

Remove the tester and accessories from the packing material and examine it carefully. If you require any further information, please contact Hanna Instruments technical support team at tech@hannainst.com.
Each HI98127 and HI98128 is delivered in a cardboard box and is supplied with:

- HI70004 pH 4.01 buffer solution, 20 mL sachet (2 pcs.)
- HI70007 pH 7.01 buffer solution, 20 mL sachet (2 pcs.)
- HI700601 pH & ORP electrode cleaning solution, 20 mL sachet (1 pc.)
- HI70300N Storage solution for pH & ORP electrodes, 20 mL sachet (1 pc.)
- HI73127 pH electrode
- HI73128 Electrode removal tool
- 1.5V batteries (4 pcs.)
- Instrument quality certificate
- Instruction manual

Note: *Save all packing material until you are sure that the tester works correctly. Any damaged or defective item must be returned in its original packing material with the supplied accessories.*

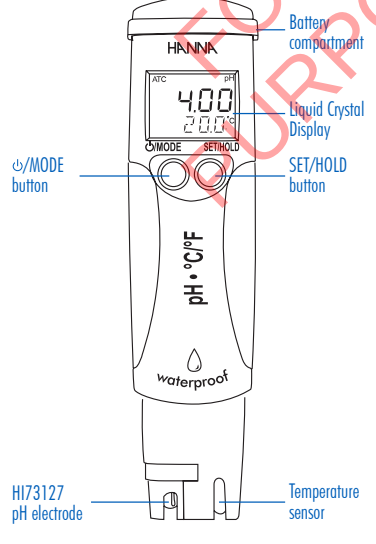
General Description & Intended Use

HI98127 (pHep®4) and HI98128 (pHep®5) are compact pH and temperature testers. They feature a two-buttons operation system and are easy to use. The compact and waterproof casing is designed to float if accidentally dropped in water. The testers measure temperature in both °C and in °F. All pH measurements are temperature compensated automatically (ATC). The testers display a stability (⏱) tag that will disappear once the reading has stabilized. Battery level and low-battery indicator are clearly displayed on the LCD to alert the user in the event that low battery power could adversely affect readings.
BEPS (Battery Error Prevention System) Tester will automatically shut off if there is not enough power to get an accurate measurement.
pH Probe: HI98127 & HI98128 are supplied together with HI73127 pH replaceable electrode with a stainless steel round connector and extendable cloth junction. This design has no pins to line up or that can break.
Temperature Sensor: The stainless steel temperature sensor facilitates faster and more accurate temperature measurement.

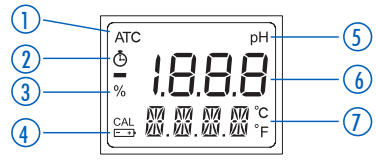
Specifications

Range	-2.0 to 16.0 pH (HI98127) -2.00 to 16.00 pH (HI98128) -5.0 to 60.0 °C (23.0 to 140.0 °F)
Resolution	0.1 pH (HI98127) 0.01 pH (HI98128) 0.1 °C (0.1 °F)
Accuracy (@25 °C / 77 °F)	±0.1 pH (HI98127) ±0.05 pH (HI98128) ±0.5 °C (±1.0 °F)
Temperature compensation	Automatic
Environment	-5 to 50 °C (23 to 122 °F); RH max 100%
Calibration	Automatic, one-, two- or (HI98128) three-point with two sets of standard buffers (pH 4.01 / 7.01 / 10.01 or pH 4.01 / 6.86 / 9.18)
Electrode	HI73127 pH electrode (included)
Battery type	1.5V (4 pcs.)
Battery life	Approx. 300 hours
Auto-off	After 8 minutes of non-use
Dimensions	171 x 41 x 26 mm (6.7 x 1.6 x 1.0")
Weight	84 g (3.0 oz)

Functional Description



LCD Display



1. Automatic Temperature Compensation (ATC) indicator
2. Stability tag
3. Battery life percentage indicator
4. Low battery indicator
5. Measurement unit
6. First LCD line
7. Second LCD line

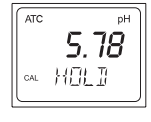
Operational Guide

Turning the Tester ON / OFF

Press and hold ⏻/MODE. All LCD segments will be displayed for a few seconds followed by battery life percentage indicator. To turn the tester off, from measurement mode, press ⏻/MODE. "OFF" will be displayed on the second LCD line and then the tester will turn off.

HOLD Mode

From measurement mode, press and hold SET/HOLD until "HOLD" is displayed. pH reading will be frozen on the LCD. Press either buttons to resume measurement mode.



Setup

Setup mode allows the selection of temperature unit and pH buffer set. To enter the setup mode, select pH mode and press ⏻/MODE until "TEMP" and the current temperature unit are displayed (e.g. "TEMP °C"). Then:

- Press SET/HOLD to select temperature unit. After the temperature unit has been selected, press ⏻/MODE to select the buffer set. To return to measurement mode, press ⏻/MODE twice.
- After setting the temperature unit, the tester will display the current buffer set: "pH7.01 BUFF" (for pH 4.01/7.01/10.01) or "pH6.86 BUFF" (for NIST pH 4.01/6.86/9.18). Press SET/HOLD to change the buffer set and press ⏻/MODE to resume measurement mode.

Calibration & Measurement

It is recommended to calibrate the tester frequently, especially if high accuracy is required. More frequent calibrations may be required depending on the type of sample being tested. The tester should be recalibrated:

- whenever the pH electrode is replaced
- at least once a month
- after testing aggressive samples

pH Calibration Procedure

From measurement mode, press and hold ⏻/MODE until "CAL" is displayed. The tester enters calibration mode and displays "pH 7.01 USE" or "pH 6.86 USE", if NIST buffer was selected. Buffer value will be displayed on the first LCD line and "REC" message will be displayed on the second line. If used buffer was not valid, "USE" message will be displayed for 12 seconds and replaced by "WRNG" indicating measured sample is not valid.

- **For one-point calibration** using pH 4.01, 10.01 or 9.18 buffer solution, once the reading has stabilized, the tester automatically accepts the calibration point. Accepted buffer point and "OK 1" message are displayed and then the tester returns to measurement mode.
- For one-point calibration using pH 7.01 (or 6.86) buffer solution, press ⏻/MODE after calibration point has been accepted. The tester will display "pH 7.01" (or "pH 6.86") and "OK 1" and then returns to measurement mode.
- **For a two-point calibration** using pH 7.01 (or 6.86) buffer solution, after the first calibration point has been accepted, "pH 4.01 USE" will be displayed for 12 seconds (unless a valid buffer is recognized).
- If valid buffer solution is recognized (pH 4.01, 10.01 or 9.18), the calibration point is accepted and the accepted value and "OK 2" are displayed. The HI98127 tester then returns to measurement mode.
- HI98128 only: If valid buffer solution is recognized (pH 4.01, 10.01 or 9.18) and the calibration point is accepted, press ⏻/MODE. The accepted value and "OK 2" are displayed. The tester then returns to measurement mode.
- **For a three-point calibration** (HI98128 only) using pH 7.01 (or 6.86) buffer value and if the first calibration point has been accepted, "pH 4.01 USE" will be displayed for 12 seconds (unless a valid buffer is recognized).
- If valid buffer solution is recognized (pH 4.01, 10.01 or 9.18), the second calibration point is accepted and the meter will display "pH 10.01 USE" (or pH 9.18) or pH 4.01 USE" for 12 seconds (unless a valid buffer is recognized).
- If the calibration point is accepted the accepted value and "OK 3" are displayed. The tester then returns to measurement mode.
- If no valid buffer solution is recognized, "WRNG" message is displayed.

Note: *When the calibration procedure is completed, the "CAL" tag is turned on.*

FOR BIDDING PURPOSES ONLY

Multi Water Quality Checker
U-50 Series

Instruction Manual

CODE:GZ0000144342C

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PURPOSES ONLY

Preface

This manual describes the operation of the Multi Water Quality Checker, U-50 Series.
Be sure to read this manual before using the product to ensure proper and safe operation of the instrument. Also safely store the manual so it is readily available whenever necessary.

Product specifications and appearance, as well as the contents of this manual are subject to change without notice.

■ Warranty and Responsibility

HORIBA warrants that the Product shall be free from defects in material and workmanship and agrees to repair or replace free of charge, at HORIBA's option, any malfunctioned or damaged Product attributable to HORIBA's responsibility for a period of one (1) year from the delivery unless otherwise agreed with a written agreement. In any one of the following cases, none of the warranties set forth herein shall be extended;

- Any malfunction or damage attributable to improper operation
- Any malfunction attributable to repair or modification by any person not authorized by HORIBA
- Any malfunction or damage attributable to the use in an environment not specified in this manual
- Any malfunction or damage attributable to violation of the instructions in this manual or operations in the manner not specified in this manual
- Any malfunction or damage attributable to any cause or causes beyond the reasonable control of HORIBA such as natural disasters
- Any deterioration in appearance attributable to corrosion, rust, and so on
- Replacement of consumables

HORIBA SHALL NOT BE LIABLE FOR ANY DAMAGES RESULTING FROM ANY MALFUNCTIONS OF THE PRODUCT, ANY ERASURE OF DATA, OR ANY OTHER USES OF THE PRODUCT.

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■ Trademarks

Generally, company names and brand names are either registered trademarks or trademarks of the respective companies.

 © 2008 – 2009 HORIBA, Ltd.

Conformable Directive

This equipment conforms to the following directives and standards:

Directives: the EMC Directive 2004/108/EC

Standards: [the EMC Directive]
EN61326-1:2006 Class B, Portable test and measurement equipment

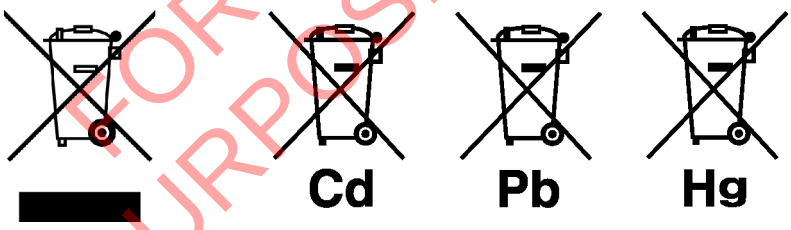
■ Information on Disposal of Electrical and Electronic Equipment and Disposal of Batteries and Accumulators

The crossed out wheeled bin symbol with underbar shown on the product or accompanying documents indicates the product requires appropriate treatment, collection and recycle for waste electrical and electronic equipment (WEEE) under the Directive 2002/96/EC, and/or waste batteries and accumulators under the Directive 2006/66/EC in the European Union.

The symbol might be put with one of the chemical symbols below. In this case, it satisfies the requirements of the Directive 2006/66/EC for the object chemical.

This product should not be disposed of as unsorted household waste.
Your correct disposal of WEEE, waste batteries and accumulators will contribute to reducing wasteful consumption of natural resources, and protecting human health and the environment from potential negative effects caused by hazardous substance in products.

Contact your supplier for information on applicable disposal methods.



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FCC Rules

Any changes or modifications not expressly approved by the party responsible for compliance shall void the user's authority to operate the equipment.

■ WARNING

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications.
Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

For your safety

Warning messages are described in the following manner. Read the messages and follow the instructions carefully.

● Meaning of warning messages

⚠ DANGER	This indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury. This signal word is to be limited to the most extreme situations.
⚠ WARNING	This indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	This indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury. It may also be used to alert against unsafe practices. Without safety alert indication of hazardous situation which, if not avoided, could result in property damage.

● Symbols

	Description of what should be done, or what should be followed
	Description of what should never be done, or what is prohibited

FOR BIDDING PURPOSES ONLY

■ Safety Precautions

This section provides precautions to enable you to use the product safely and correctly and to prevent injury and damage. The terms of DANGER, WARNING, and CAUTION indicate the degree of imminency and hazardous situation. Read the precautions carefully as it contains important safety messages.

⚠ WARNING
Do not disassemble or modify the meter. May cause overheating or fire, resulting in accidents.

⚠ CAUTION
The pH and ORP sensors are made of glass. Handle them carefully to avoid breakage.
Do not ingest the DO, pH or ORP standard solutions. If it comes into contact with the eyes, rinse thoroughly with water. If swallowed, consult a physician.
Keep away from water when using USB communication. Improper use may result in fire or damage.

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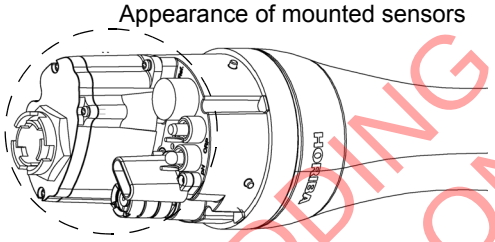
Points of concern

Use of the equipment in a manner not specified by the manufacturer may impair the protection provided by the equipment. It may also reduce equipment performance.

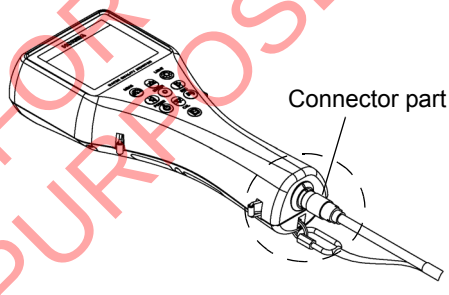
Sensor probe

- Do not immerse the sensor probe in seawater or other samples with high salinity. Doing so may erode metallic parts. After use, promptly wash the sensor probe thoroughly in water.
- Do not immerse the sensor probe in alcohol, organic solvent, strong acid, strong alkaline, and other similar solutions.
- Do not subject to strong shocks.
- Do not perform measurement in environments of magnetic fields. Measurement errors may result.
- The sensor probe is no longer waterproof when the sensors are not mounted.

Appearance of mounted sensors



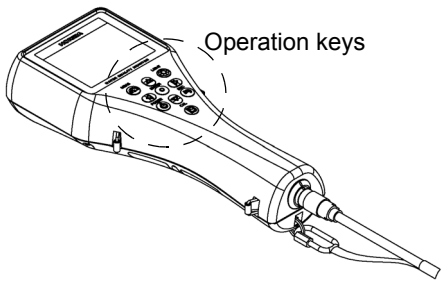
- Does not support measurement of samples containing fluorine.
- To disconnect the sensor cable or interface cable, pull them out with holding the connector part. Do not pull the cable part; it may cause breakage.



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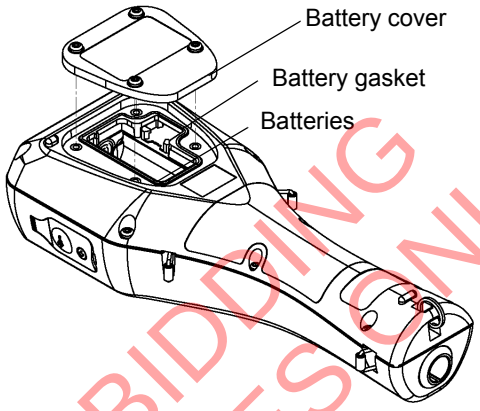
Control unit

- Do not subject to strong shocks.
- The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.



- The control unit is no longer waterproof when the USB cable is connected.
- When operating the control unit only, protect the connector with the connector cap provided.

- Remove the batteries when not using the control unit for an extended period of time. Battery fluid leakage may cause equipment failure.
- Do not wipe the control unit with organic solvents or powder polish. The surface may deteriorate or its printing may disappear. If the display becomes dirty, wipe the dirt off with a soft cloth soaked in neutral detergent.
- Do not turn the power OFF or disconnect the cable during calibration or setting. Memory data may be erased.
- To perform measurement, connect the sensor probe cable before turning the power ON.
- Do not remove the battery gasket or twist it.
- When opening the battery case, make sure that no foreign matter is attached to the battery gasket.
- Do not use any unspecified batteries; it may cause breakage.



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Measurement

- Do not pull the cable when lowering the sensor probe into the sample during measurement. Lower the sensor probe into the sample on a chain or string.
- Before lowering the sensor probe into the sample, do not connect the hook on the unit to a human body.
- The correct values are not displayed if the sensor is not mounted when the measurement display is activated.
- Perform DO measurement with no air bubbles in the internal solution.
- Do not reuse a membrane cap of DO sensor.
- Use the spanner for DO sensor provided to attach or remove the DO sensor.
- Avoid both U-53 and U-53G turbidity measurement in air, since the rubber wiper will quickly become damaged.
- Avoid turbidity measurement in direct sunlight, since the readout may be affected.

Calibration

During atmosphere calibration for the DO electrode with DO salinity compensation set to automatic, values are compensated based on electrical conductivity, but calibration is performed normally.

Location of use and storage

- Storage temperature: −10°C to 60°C
- Relative humidity: Under 80% and free from condensation

Store the meter in locations void of dust, strong vibrations, direct sunlight, corrosive gases, near air conditioners or windy areas.

Disposal of the product

When disposing of the product, follow the related laws and/or regulations of your country for disposal of the product.

Description in this manual

Note

This interprets the necessary points for correct operation and notifies the important points for handling the unit.

Reference

This indicates where to refer for information.

Tip

This indicates reference information.

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1 About this Unit

The U-50 Series Multi Water Quality Checker features an integrated control unit and sensors. It is capable of making a maximum of eleven simultaneous measurements for various parameters, and is perfect for use in the field. The U-50 Series is designed with on-site ease-of-use in mind, provides a wide variety of functions, and can be used for water quality measurements and inspections of river water, groundwater, and waste water.

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2 Device Information

2.1 Measurement parameters

Parameters	Model				
	U-51	U-52	U-52G	U-53	U-53G
pH (pH)	✓	✓	✓	✓	✓
pH (mV)	✓	✓	✓	✓	✓
Oxidation reduction potential (ORP)	✓	✓	✓	✓	✓
Dissolved oxygen (DO)	✓	✓	✓	✓	✓
Electrical conductivity (COND)	✓	✓	✓	✓	✓
Salinity (SAL) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Total dissolved solids (TDS) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Seawater specific gravity (SG) [expressed as electrical conductivity]	✓	✓	✓	✓	✓
Water temperature (TEMP)	✓	✓	✓	✓	✓
Turbidity (TURB) [LED transmission/front 30° scattering method]	–	✓	✓	–	–
Turbidity (TURB) [tungsten lamp 90° transmission/scattering method] with wiper	–	–	–	✓	✓
Water depth (DEP)	–	–	✓	✓	✓
GPS	–	–	✓	–	✓

"✓" indicates a measurable parameter.

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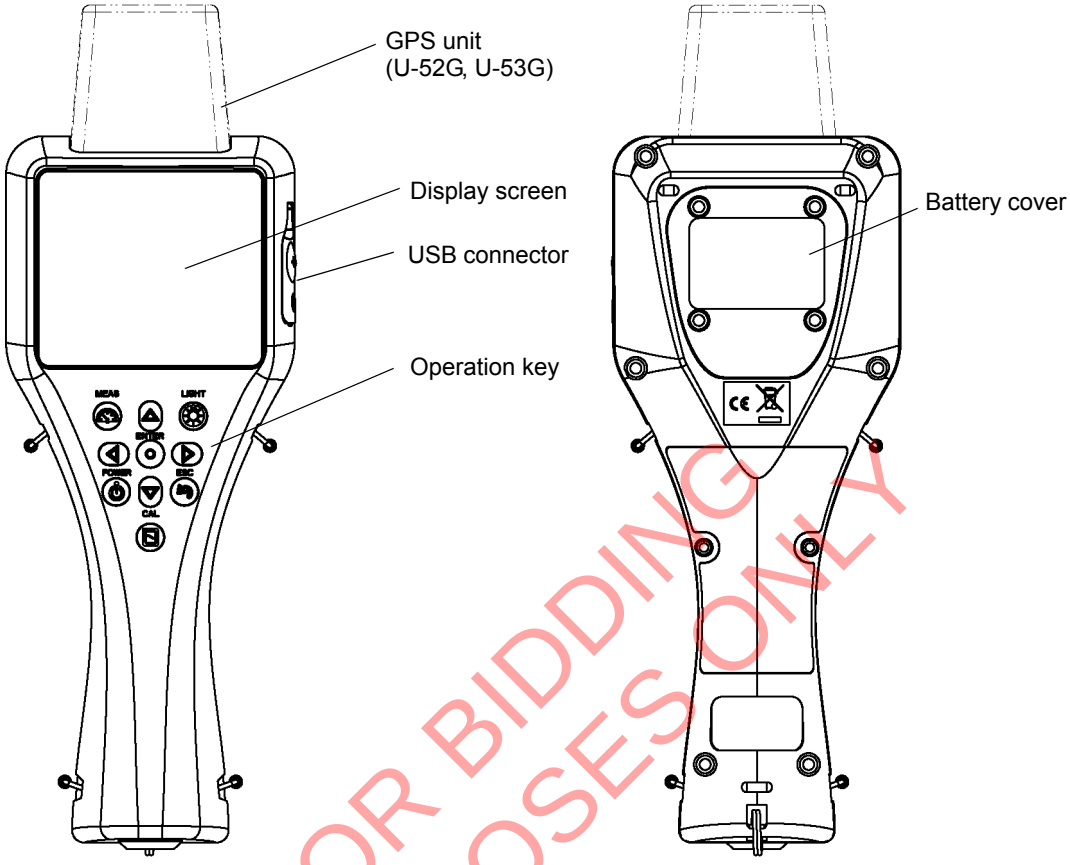
2.2 Packing list

Parts Name	Quantity	Note
Control unit	1	
Sensor probe	1	
pH sensor (#7112)	1	
ORP sensor (#7313)	1	
Reference electrode (#7210)	1	
DO sensor (#7543)	1	
Turbidity sensor (#7800)	1	With U-52/U-52G only. Attached to the sensor probe.
Turbidity sensor (#7801)	1	With U-53/U-53G only. Attached to the sensor probe.
pH 4 standard solution (#100-4)	1	500 mL
pH reference internal solution (#330)	1	250 mL
DO sensor internal solution set (#306)	1	Internal solution (50 mL), Sandpaper (#8000, #600), Syringe
DO Membrane spare parts set	1	
Spanner for DO sensor	1	
Cleaning brush	1	
calibration cup	1	transparent calibration cup, black calibration cup
Back pack	1	
Strap	1	
Alkaline batteries	4	LR14
Silicon grease	1	
Instruction manual	1	

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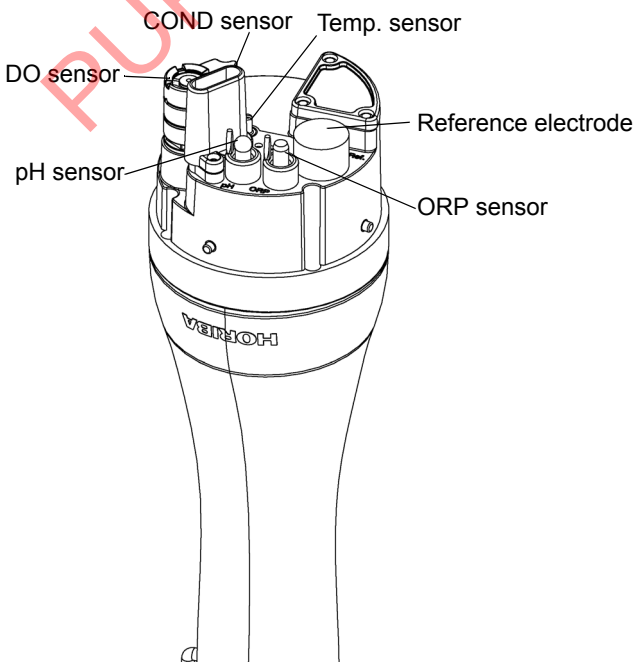
2.3 Parts name and functions

● Display

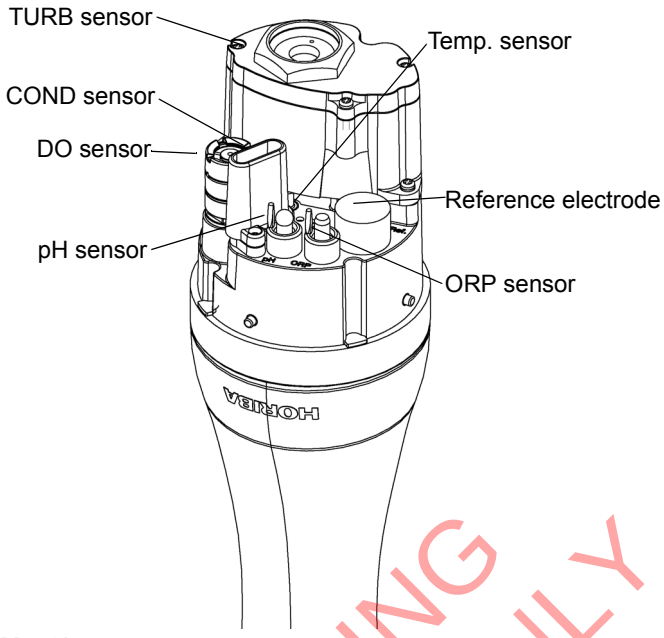


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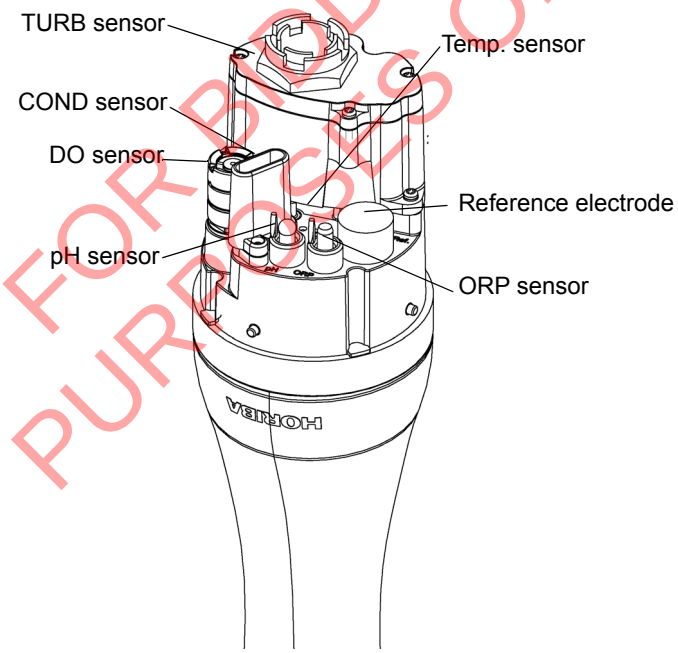
● Sensor probe (U-51)



● Sensor probe (U-52)

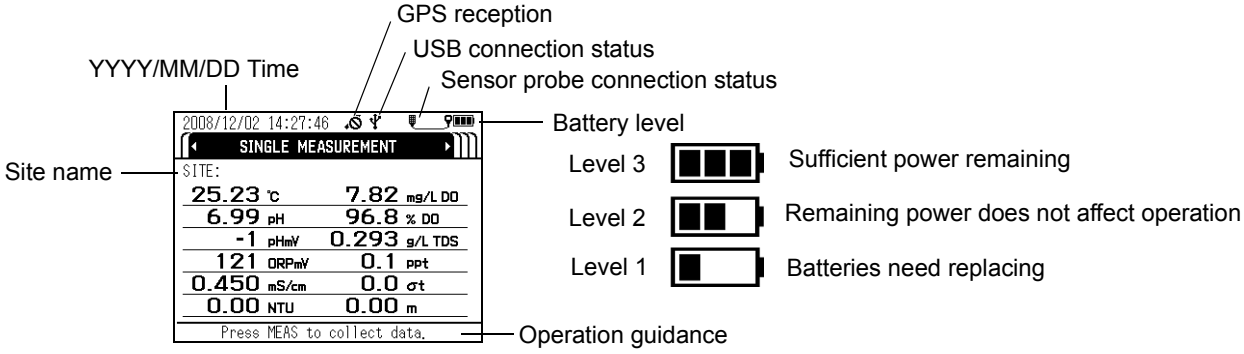


● Sensor probe (U-53)



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● Display screen

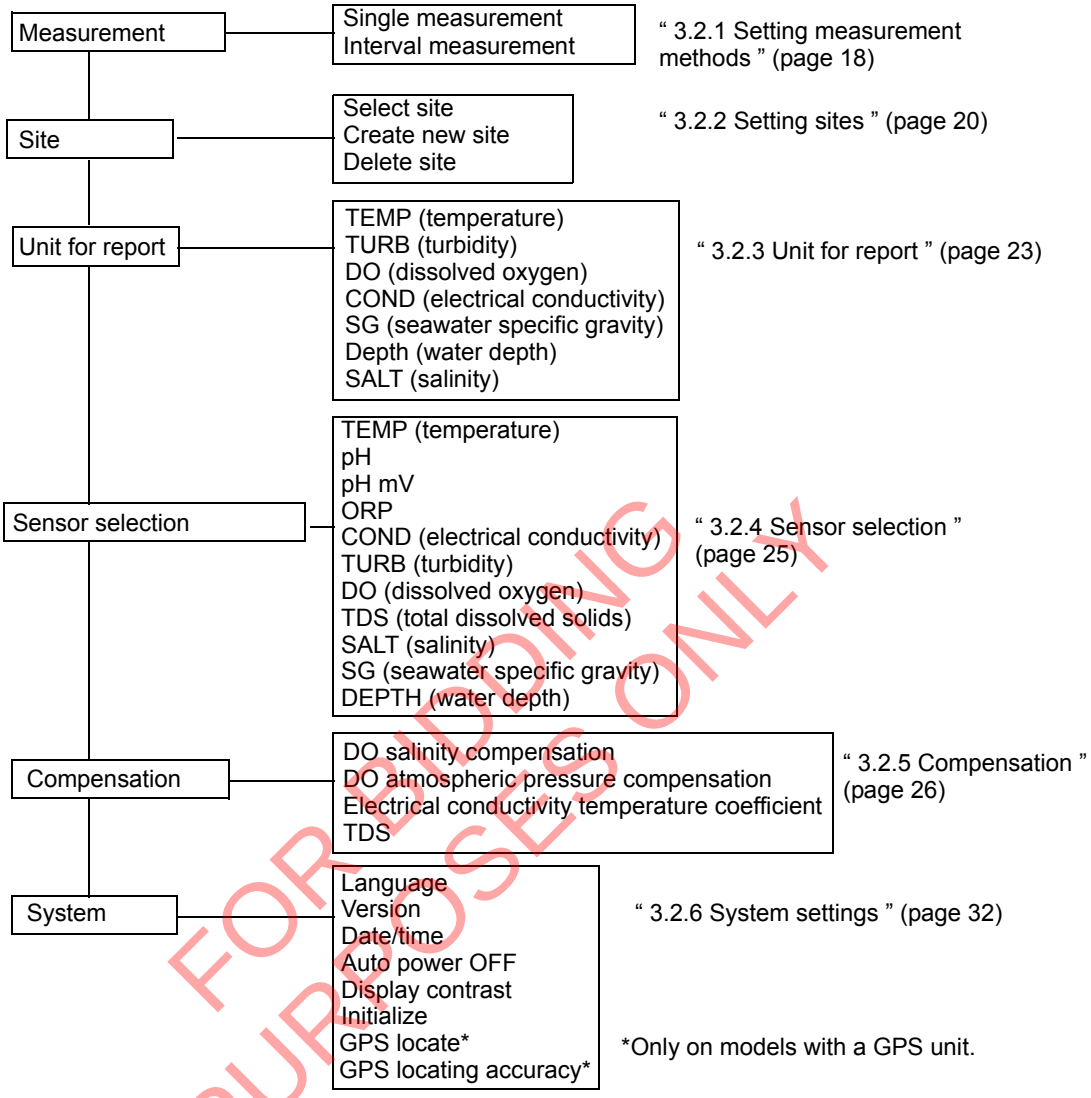


● Operation key

	Key name	description
	POWER key	Turns the system's power ON/OFF. The initial screen appears immediately after turning the power ON. Press and hold down the POWER key for about 3 seconds to turn the power ON and OFF.
	MEAS key	When pressed in the measurement screen, used to set the measurement values of all the measurement parameters. Measurement values flash until the data stabilizes.
		When pressed in the setting, calibration or data operation screen, returns to the measurement screen.
	ENTER key	Used to execute functions, set entered values or store data in memory.
	CAL key	Switches to the calibration screen.
	ESC key	Returns to the immediately preceding operation.
	LIGHT key	Turns the backlight ON/OFF. ● Using the backlight shortens battery life. ● The backlight does not light for about 3 seconds after power ON. ● When the sensor probe is connected while the display's backlight is lit, the backlight goes out for about 3 seconds.
	Left key	Moves the cursor to the left.
	Right key	Moves the cursor to the right.
	Up key	Moves the cursor up.
	Down key	Moves the cursor down.

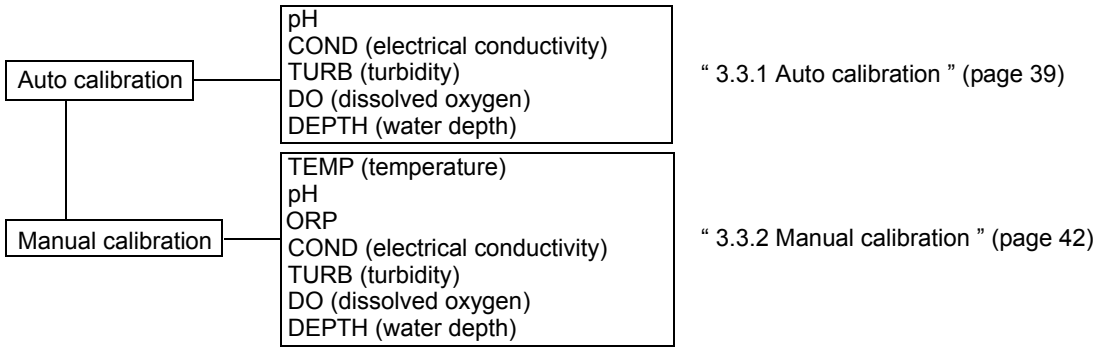
FOR BIDDING PURPOSES ONLY

2.4 Setting menu items

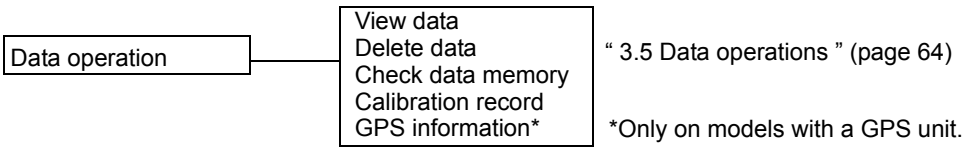


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2.5 Calibration menu items



2.6 Data operation menu items



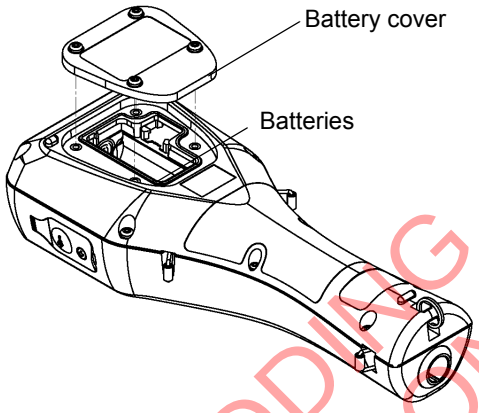
3 Basic Operation

3.1 System setup

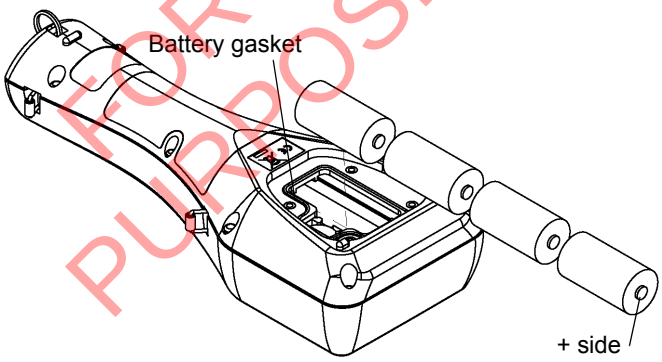
3.1.1 Inserting and replacing the batteries

The control unit is shipped without batteries. Follow the steps below to insert the batteries when using the system for the first time or replacing old batteries.

1. **Loosen the 4 screws on the battery cover by using No. 2 Phillips head screwdriver and remove the cover.**



2. **If replacing the batteries, discard the old batteries.**
3. **Insert new batteries in the control unit.**
   Check that the battery gasket is not dirty or twisted.



4. **Replace the battery cover and fasten it with the 4 screws.**
   Tighten the screws to less than 0.5 N·m.

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Note

- **Data and settings will not be lost when the batteries are replaced.**
- **If dirty or twisted, the battery gasket will fail to keep the batteries dry. Check its condition before closing the cover.**
- **To ensure long service life, replacing the battery gasket periodically (once a year) is recommended.**

Precautions when using dry cell batteries

- **Batteries to use: LR14 alkaline dry cell batteries (C-size dry cell batteries) or rechargeable nickel-metal hydride dry cell batteries (C-size)**
  Do not use manganese batteries.
- **Dry cell batteries used incorrectly may leak or burst. Always observe the following**
  - Orient the batteries correctly (positive and negative ends in correct positions).
  - Do not combine new and used batteries, or batteries of different types.
  - Remove the batteries when not using the system for a prolonged period.
  - If batteries leak, have the system inspected at your nearest Horiba service station.

● Battery life

- The battery life for continuous operation when using C-size alkaline dry cell batteries is about 70 hours.
- Using the backlight consumes a proportionate amount of battery power, shortening battery life.
- Searching position information using the GPS unit consumes a proportionate amount of battery power, shortening battery life.
- Nickel-metal hydride secondary batteries can be used, but the battery life is not guaranteed since it will vary according to usage (number of times data is saved, number of charges and amount of each charge). In general, secondary batteries have one-half to one-third the life of C-size alkaline batteries.
- The 70-hour battery life figure applies to a control unit operating temperature of 20°C or more. The battery characteristics shorten the battery life at operating temperatures lower than 20°C, so check the remaining battery level, and replace the batteries before it reaches Level 1.
- The batteries packed with the system at the time of shipment are for checking operation. Their life is not guaranteed.
- The 70-hour battery life figure is the amount of operating time the batteries can provide until the system stops operating. The system may fail during operation if the remaining battery level is low, so it is a good idea to check the remaining battery level and replace the batteries with new ones well before the batteries run out completely.

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U-51/52

Battery life: 70 hours (backlight off)

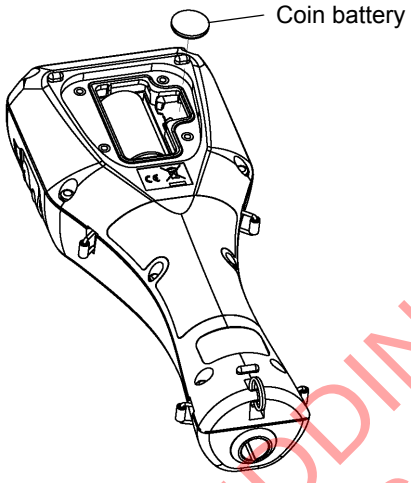
U-53

Battery life: 500 measurements (backlight off)

- Since U-53 is designed for turbidity measurement with wiper, its battery life is estimated in terms of the number of turbidity measurement sequences performed.
- Battery power is also consumed by measurement operations other than turbidity measurement.
- The battery life when turbidity measurement is not performed is about 70 hours.

3.1.2 Replacing the coin battery

- Coin battery to use: CR-2032
- The coin battery is only for the clock. It will provide problem-free operation for three years, but when using the clock continuously, it should be replaced every two years as a precaution.
- When replacing the coin battery for the clock, leave the control unit ON. If the coin battery is replaced when the control unit is turned OFF, the clock will be reset to the default settings.



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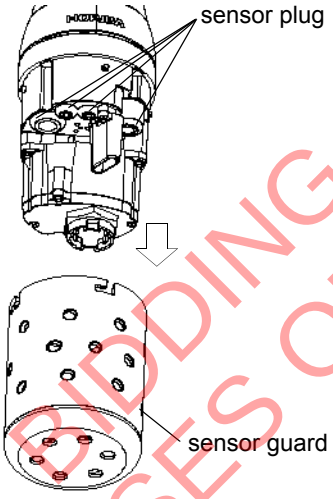
3.1.3 Attaching sensors

Note

- When attaching or replacing a sensor, wipe any moisture off the sensor probe and sensor.
- Be sure to keep water out of sensor connectors. If moisture comes in contact with a sensor connector, blow-dry it with dry air.
- The sensor probe is not waterproof when the sensor is not mounted.
- Take care not to tighten the sensor too much.

● Attaching the pH sensor

1. Remove the sensor guard.

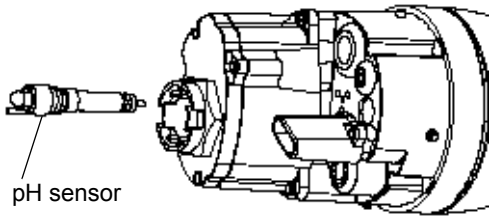


2. Remove the sensor plug.
3. Coat the pH sensor O-ring with a thin layer of silicon grease (part No. 3014017718).

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. Make sure there is no moisture on the sensor probe's sensor connector (marked "pH").
5. Fasten the pH sensor securely by hand.



6. Clean the sensor with an alcohol-soaked cloth.

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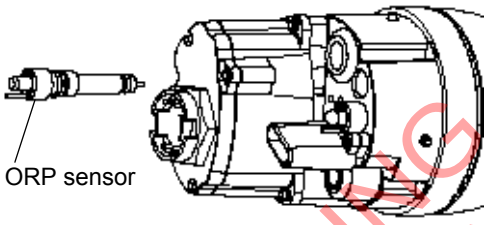
Attaching the ORP sensor

1. Remove the sensor guard.
2. Remove the sensor plug.
3. Coat the ORP sensor O-ring with a thin layer of grease (part No. 3014017718).

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. Make sure there is no moisture on the sensor probe's sensor connector (marked "ORP").
5. Fasten the ORP sensor securely by hand.



6. Clean the sensor with an alcohol-soaked cloth.

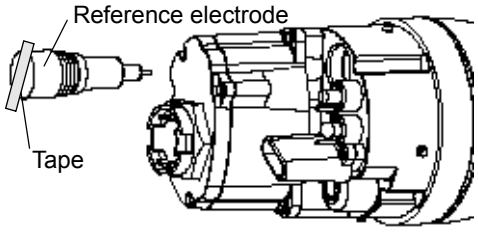
Attaching the reference electrode

1. Remove the sensor guard.
2. Remove the sensor plug.
3. Coat the reference electrode O-ring with a thin layer of grease (part No. 3014017718).

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

4. Make sure there is no moisture on the sensor probe's sensor connector (marked "REF").
5. Fasten the reference electrode securely by hand.
6. Remove the tape from the liquid junction part of the reference electrode.



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Attaching the dissolved oxygen (DO) sensor

1. **Remove the membrane cap mounted on the DO sensor beforehand, and replace it with the new membrane cap provided. Replace the internal solution with fresh solution. The main component of the internal solution is potassium chloride (KCl), so the old solution can be disposed of down a sink or other drain.**

Reference

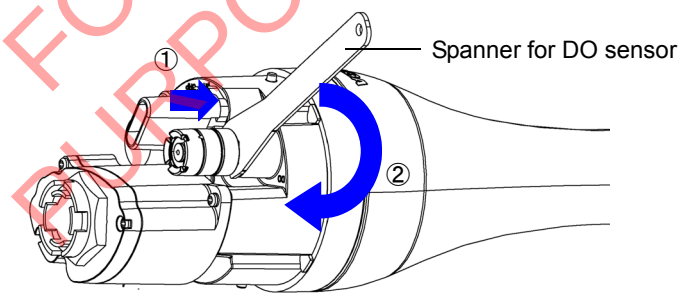
“ 4.5 Replacing the membrane cap ” (page 87)

2. **Screw in the DO sensor to attach it, allowing the internal solution to overflow slightly.**
3. **Use a soft cloth to wipe off the internal solution that overflowed onto the DO sensor.**
4. **Remove the sensor guard.**
5. **Remove the sensor plug.**
6. **Coat the DO sensor O-ring with a thin layer of grease (part No. 3014017718).**

Note

Be sure no grease from the O-ring gets on the sensor connector. If the sensor connector gets grease on it, wipe it off with a soft cloth soaked in alcohol.

7. **Make sure there is no moisture on the sensor probe’s sensor connector (marked "DO").**
8. **Fasten the DO sensor securely using the spanner for DO sensor.**
   - Hold the DO sensor with the provided spanner for DO sensor and push the sensor down. (Step 1 in figure below)
   - Screw the DO sensor in place. (Step 2 in figure below)

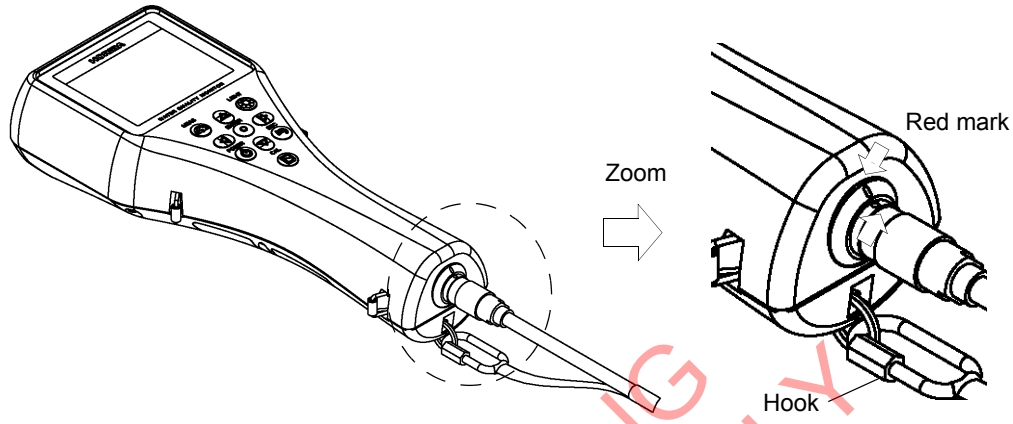


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3.1.4 Connecting the control unit and sensor probe

Note

Connect the control unit with its power OFF.

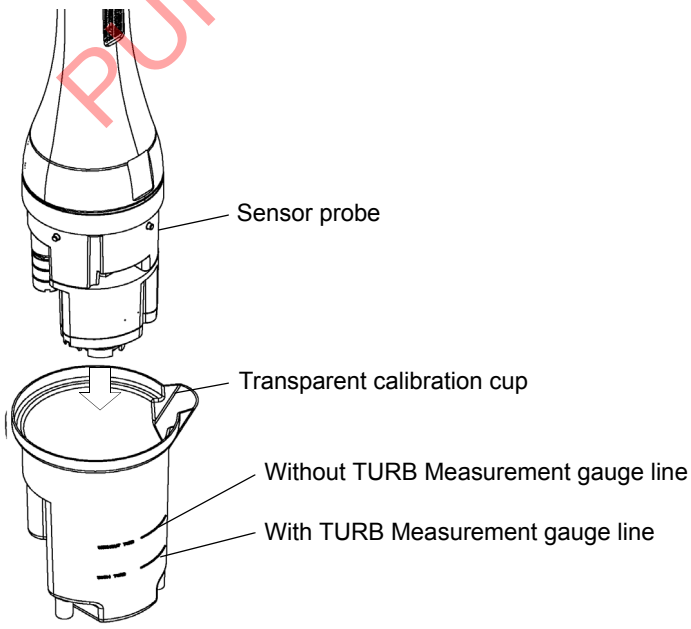


1. **Align the red mark on the connector, and press the connector in until you hear it click.**
2. **Connect the cable's hook to the display.**

3.1.5 Conditioning

Carry out the steps below when using the unit for the first time or when the system has not been used for 3 months or longer.

1. **Fill the transparent calibration cup to the line with pH 4 standard solution.**
   The transparent calibration cup has With TURB Measurement and Without TURB Measurement gauge lines.
2. **Insert the sensor probe in the transparent calibration cup.**



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Note

Check that all sensors are attached.

3. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON. Leave the unit for at least 20 minutes to condition the sensors.**

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

Tip

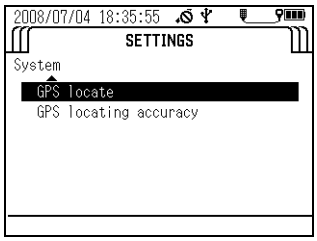
- **The procedure for immersing the sensor probe in the pH standard solution is the same as that described in " 3.3.1 Auto calibration " (page 39).**
  Auto calibration can be performed using the same pH 4 standard solution that was used in the conditioning procedure.
- **Immersing the sensor in the standard solution is generally required for sensor conditioning, but a voltage supply is required for DO sensor conditioning. Turning ON the power of the control unit is necessary during sensor conditioning.**

3.1.6 GPS (U-52G, U-53G)

The GPS position measurement precision is proportional to the GPS position measurement time. When the position measurement precision increases, the position measurement time also increases. See " ● GPS locating accuracy" (page 17) for how to set the position measurement precision. See " ● GPS locate" (page 15) below for how to check acquired GPS data.

● GPS locate

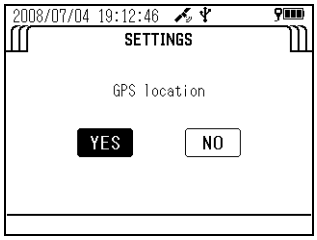
1. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
2. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**
3. **Press the down (▽) key to move the cursor to "GPS locate", then press the ENTER key.**



4. **The message "Press ENT key to start position measurement." appears. Press the ENTER key.**

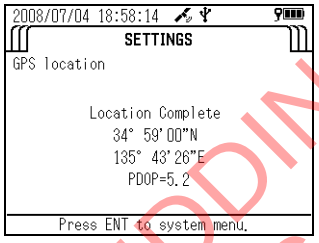
FOR BIDDING PURPOSES ONLY

5. **The message "Execute GPS position measurement?" appears. Move the cursor to "YES", then press the ENTER key.**

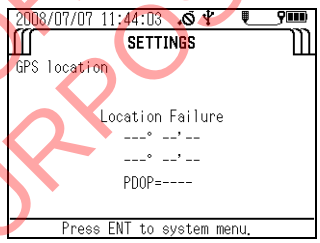


6. **The message "Warming up. Please wait." appears. Wait until the system has finished warming up (about 10 seconds).**

- Position measurement starts automatically when warmup has finished. Position measurement is performed up to 10 times.
- The GPS location complete screen appears after successful position measurement.



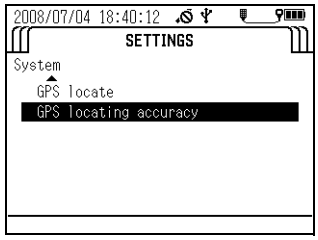
- The GPS location failure screen appears after position measurement has failed. Redo the measurement in a location free from obstacles, or wait for the meteorological conditions to improve before redoing the measurement.



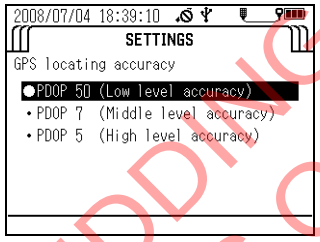
FOR BIDDING PURPOSES ONLY

● GPS locating accuracy

1. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
2. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**
3. **Press the down (▽) key to move the cursor to "GPS locating accuracy", then press the ENTER key.**



4. **The screen below appears. Move the cursor to the locating accuracy, then press the ENTER key. The black circle (●) indicates the currently set precision.**



FOR BIDDING PURPOSES ONLY

3.2 Settings

3.2.1 Setting measurement methods

This section describes how to set the measurement method.

● Measurement methods

● U-51/U-52

Single measurement	Pressing the MEAS key acquires the 5-second average for the selected measurement parameter.
Interval measurement	Pressing the MEAS key acquires and saves the 5-second average for the selected measurement parameter in the set interval. The measurement interval can be set to any value between 10 seconds and 24 hours.

● U-53

The U-53 turbidity sensor uses a tungsten lamp. The lamp lights for about 10 seconds, and the average measurement value acquired during this interval is displayed.

Single measurement	Pressing the MEAS key acquires the 5-second average for the selected measurement parameter after wiper operation. The 10-second average is acquired when measuring turbidity.
Interval measurement	Pressing the MEAS key acquires and saves the 5-second average for the selected measurement parameter in the set interval. The 10-second average is acquired when measuring turbidity. The measurement interval can be set to any value between 10 seconds (final check of this value required; 30 seconds may be better for U-52) and 24 hour.

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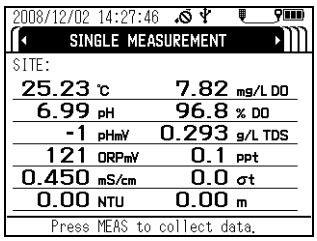
Reference

“ 3.4 Measurement ” (page 61)

● Operation method

1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**

The "MEASUREMENT" screen appears after about 10 seconds.

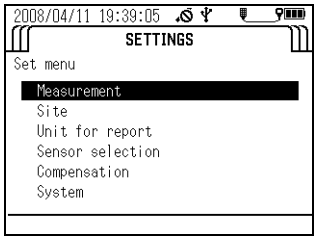


Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

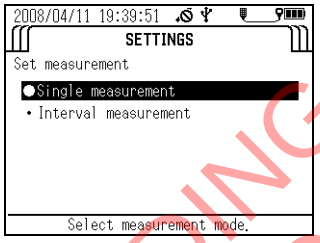
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "Measurement", then press the ENTER key.**



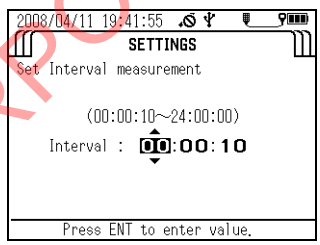
4. **Press the down (▽) key to move the cursor to the desired measurement mode. Press the ENTER key to save the setting.**

The black circle (●) indicates the currently selected measurement mode.



5. **If you selected "Interval measurement", the display switches to the screen used to set the measurement interval. Press the up (△) and down (▽) keys to set the measurement interval.**

The measurement interval can be set to any value between 10 seconds and 24 hours in the case of the U-51 and U-52, or between 30 seconds and 24 hours in the case of the U-53.



FOR BIDDING PURPOSES ONLY

3.2.2 Setting sites

The site function allows position data to be connected to corresponding measurement data. Sites have the following specifications and features:

Site names: Text data consisting of up to 20 one-byte alphanumeric characters, spaces, etc.
Site names can be used for control unit searches and as labels for computer processing.
Site names allow measurement data to be saved with a name corresponding to the actual location where it was measured.

You can use site information as a search key when viewing data uploaded by a PC or data saved in the control unit (see “ 3.5 Data operations ” (page 64)).

- **Selecting sites**

  You can select previously created sites. The black circle (●) indicates the name of the currently selected site. No sites are created at new purchasing or after initialization. Select a site after first creating one from the "Create new site" menu.

- **Creating new sites**

  You can create and save new sites. Up to 20 site names can be registered.

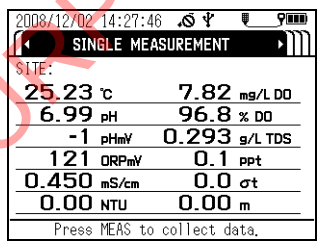
- **Deleting sites**

  You can select a previously created site and delete it.

● Operation methods

- **Selecting a site**

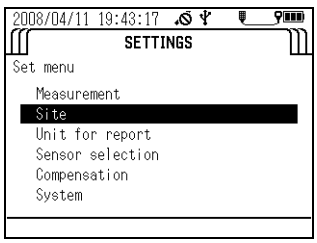
  1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**
     The "MEASUREMENT" screen appears after about 10 seconds.



Note

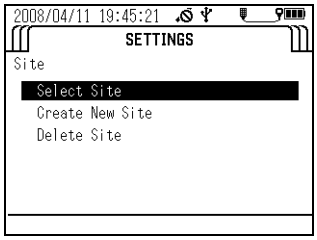
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

  2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
  3. **Press the down (▽) key to move the cursor to "Site", then press the ENTER key.**

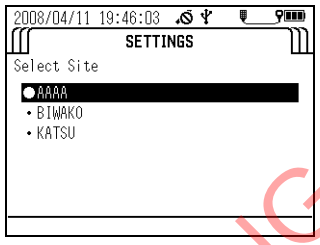


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4. **Press the down (▽) key to move the cursor to "Select Site", then press the ENTER key to display the names of the currently saved sites.**

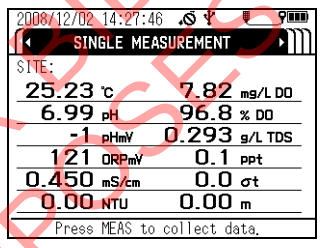


The black circle (●) indicates the currently selected site.



● **Creating a new site**

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
The "MEASUREMENT" screen appears after about 10 seconds.



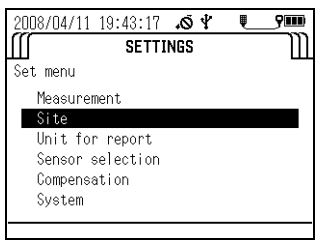
FOR BIDDING PURPOSES ONLY

Note

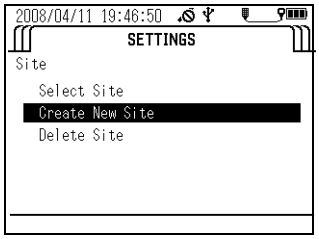
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

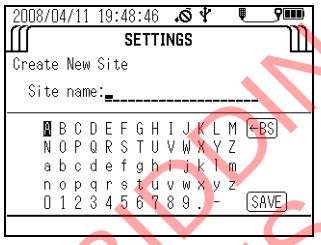
3. **Press the down (▽) key to move the cursor to "Site", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Create New Site", then press the ENTER key.**
   Enter the desired site name (up to 20 alphanumeric non-Asian width characters).



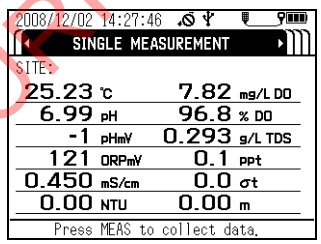
5. **Press the up (△), down (▽), right (▷), and left (◁) keys to move the cursor to each letter or number to use in the name, then press the ENTER key to confirm the entered characters. To delete incorrectly entered characters, move the cursor to "BS" and press the ENTER key to start deleting from the last character. When you have finished entering the name, save it by moving the cursor to "SAVE" and pressing the ENTER key.**



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● Deleting a site

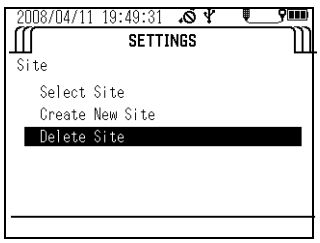
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

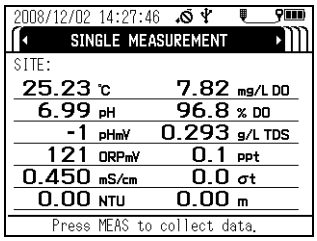
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**



3. **Press the down (▽) key to move the cursor to "Site", then press the ENTER key.**

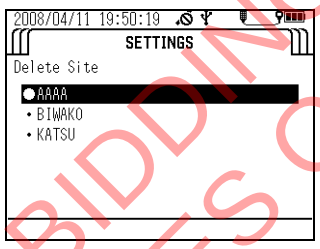
4. **Press the down (▽) key to move the cursor to "Delete Site", then press the ENTER key.**

   A list of the currently saved sites appears. The black circle (●) indicates the currently selected site.



5. **Press the down (▽) key to move the cursor to the site to delete, then press the ENTER key to delete it.**

   The currently selected site can be deleted after a different site has been selected from the site selection menu or after all unselected sites have been deleted. The same site name cannot be registered more than once.



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3.2.3 Unit for report

Note

Units can only be selected when the sensor probe is connected.

Follow the steps below to set the measurement units of measurement parameters. No units are displayed if a measurement parameter has not been selected in the measurement parameter selection screen (see “ 3.2.4 Sensor selection ” (page 25)).

1. **Press and hold down the control unit’s POWER key for about 3 seconds to turn the power ON.**

   The "MEASUREMENT" screen appears after about 10 seconds.

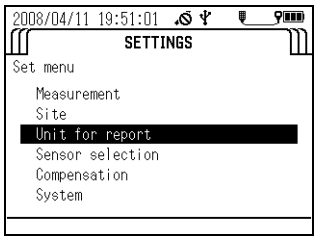
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

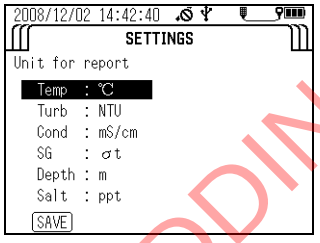
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. Press the down (▽) key to move the cursor to "Unit for report", then press the ENTER key.

A list of the currently selected measurement parameters and their units appears. Note that measurement parameters not selected (in the measurement parameter selection screen) are not displayed.

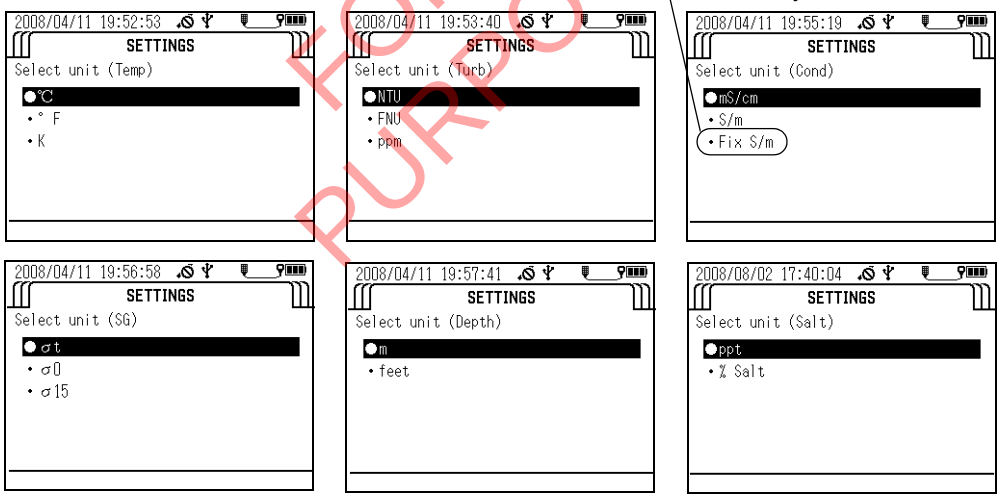


4. Press the up (△) and down (▽) keys to move the cursor to the item to change, then press the ENTER key.

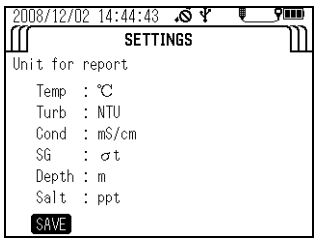


5. A list of the units that can be selected appears. The black circle (●) indicates the currently selected unit. Press the up (△) and down (▽) keys to move the cursor to the desired unit, then press the ENTER key.

Fix S/m: Fixes S/m with no auxiliary units for any measurement range.



6. To save the changes, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you do not want to save the changes, press the ESC key.



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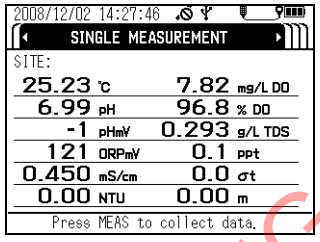
3.2.4 Sensor selection

Note

Measurement parameters can only be selected when the sensor probe is connected.

You can set between 1 and 11 measurement parameters to display in the control unit screen. Follow the steps below to select the desired measurement parameters.

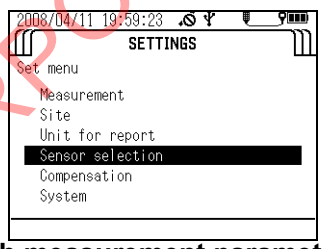
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



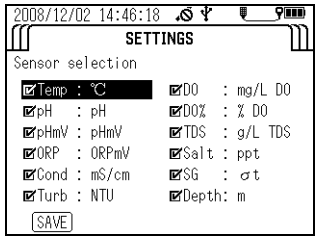
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Sensor selection", then press the ENTER key.**
   A list of the measurement parameters that can be set and the currently set units are displayed.



4. **Move the cursor to each measurement parameter to change, then press the ENTER key.**
   A check in the check box of a measurement parameter indicates it will be displayed.
5. **To save the changes, press the up (△), down (▽), left (◁) and right (▷) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the changes, press the ESC key.**



Note

Available measurement parameters differ according to product specifications.

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3.2.5 Compensation

Note

Compensation settings can only be made when the sensor probe is connected.

U-50 series have following functions of compensation.

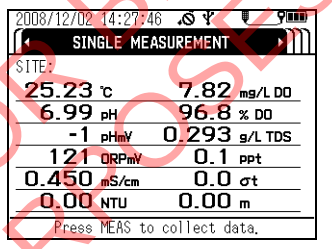
- Salinity compensation and atmospheric pressure compensation for dissolved oxygen (DO)
- Temperature compensation for conductivity (COND)
- Setting total dissolved solid (TDS) coefficient for TDS

● Salinity compensation (DO)

The dissolved oxygen (DO) value is presented higher than actual value if salinity compensation is not added, because the increase of salinity gives higher DO value. To obtain correct value salinity compensation is needed. The following modes are available for calculation of salinity compensation.

AUTO:	Salinity compensation is performed automatically with salinity converted from conductivity.
Value input:	Press the up (△) and down (▽) keys to enter a setting value when the salinity is known.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
The "MEASUREMENT" screen appears after about 10 seconds.



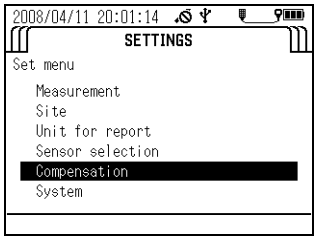
FOR BIDDING PURPOSES ONLY

Note

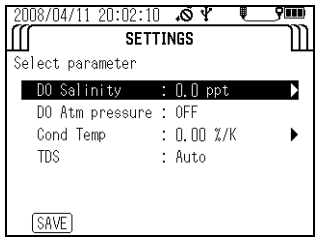
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

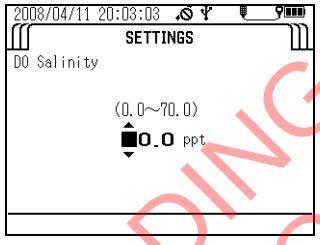
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**



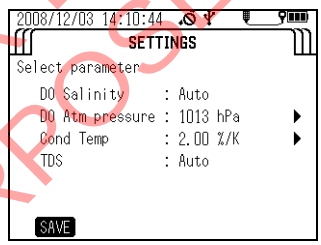
4. **Press the down (▽) key to move the cursor to "DO Salinity", then press the ENTER key to toggle the setting between "Auto" and "Input mode".**
   Default: Auto



5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.**

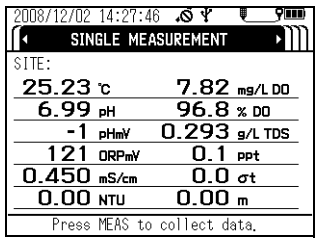


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● **Atmospheric pressure compensation (DO)**

Differences in the atmospheric pressure of the measurement location influence the Dissolved Oxygen (DO) measurement. By setting (input) the actual atmospheric pressure of the measurement location into the control unit, it is possible to standardize the measured Dissolved Oxygen (DO) value to a value at the standard atmospheric pressure (1013 hPa).

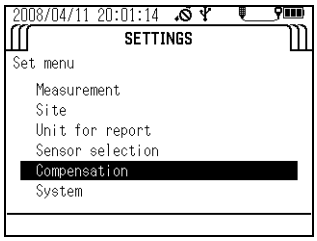
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



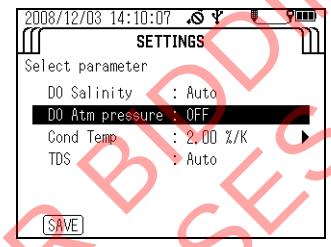
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

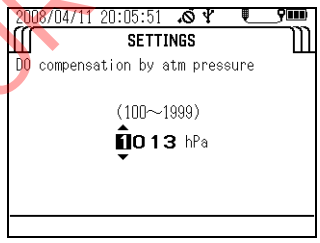
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**



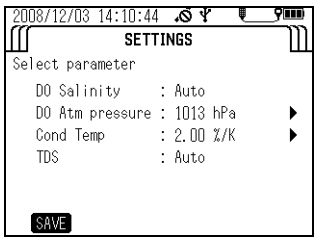
4. **Press the down (▽) key to move the cursor to "Cond Temp", then press the ENTER key to toggle the setting between "OFF" and "Input mode".**
   Default: OFF



5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.**

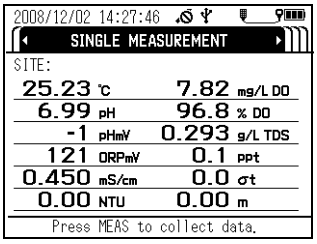


FOR BIDDING PURPOSES ONLY

Temperature compensation for conductivity (COND)

Sample conductivity (COND) varies with temperature, and this control unit uses a temperature compensation coefficient to automatically standardize the conductivity (COND) at 25°C. The initial setting coefficient is 2%/K, which is the generally used.

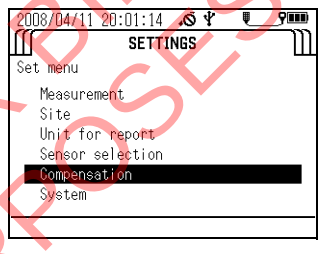
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



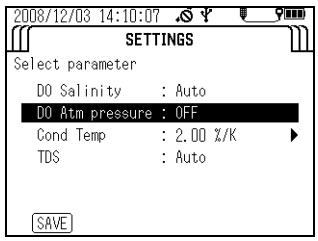
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**

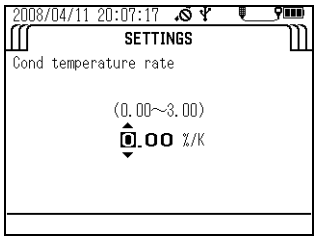


4. **Press the down (▽) key to move the cursor to "Cond Temp", then press the ENTER key to toggle the setting between "OFF" and "Input mode".**
   Default: 2.00%/K

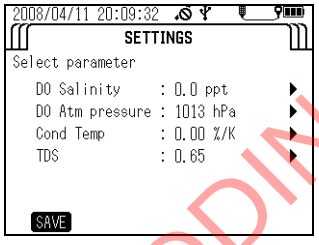


FOR BIDDING PURPOSES ONLY

5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key.**
If you don't want to save the change, press the ESC key.



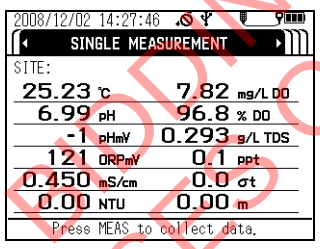
FOR BIDDING PURPOSES ONLY

Setting a total dissolved solid (TDS) coefficient

The total dissolved solid amount (TDS) is a converted value obtained by multiplying the conductivity (COND) by a known coefficient. The coefficient initially set for the control unit is based on a conversion for KCl and $CaCO_3$ solutions and it depends on the conductivity (COND) value as shown below.

Conductivity (COND) (S/m)	Conversion coefficient
< 0.05	0.65
0.05 to 0.5	0.64
0.5 to 1	0.63
1 to 3	0.62
3 to 5	0.61
> 5	0.60

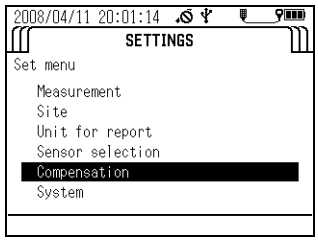
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



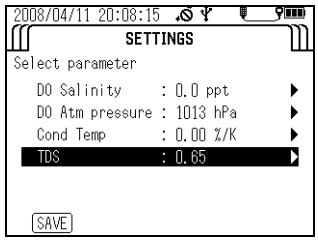
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "Compensation", then press the ENTER key.**

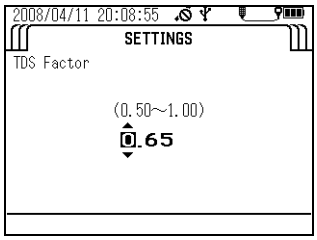


4. **Press the down (▽) key to move the cursor to "TDS", then press the ENTER key to toggle the setting between "AUTO" and "Input mode".**
   Default: Auto

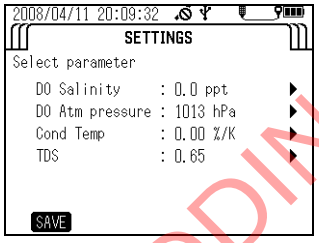


FOR BIDDING PURPOSES ONLY

5. **If you selected "Input mode", press the right (▷) key to display the compensation value input screen. Press the up (△) and down (▽) keys to enter the desired value, then press the ENTER key to set it.**



6. **To save the change, press the up (△) and down (▽) keys to move the cursor to SAVE, then press the ENTER key. If you don't want to save the change, press the ESC key.**



FOR BIDDING PURPOSES ONLY

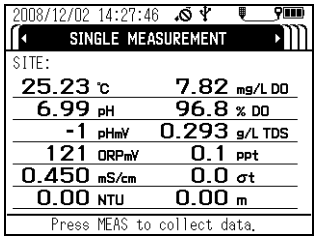
3.2.6 System settings

The system settings let you change the display language, check the system software version, set the date/time, set the auto power OFF time, set the display contrast, and initialize the settings.

● **Display language**

Follow the steps below to select either English or Japanese as the display language.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.

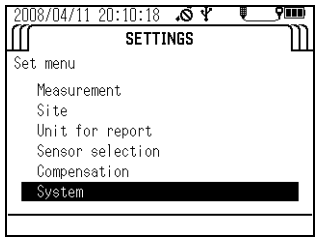


Note

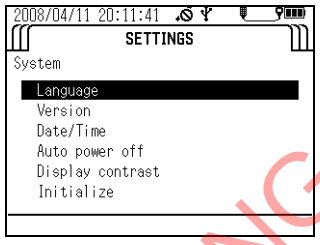
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

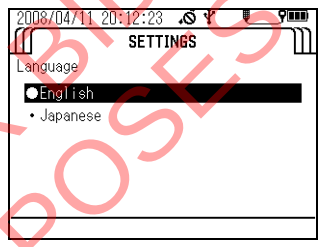
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Language", then press the ENTER key.**



5. **A list of the supported display languages appears. Press the up (△) and down (▽) keys to move the cursor to the desired language, then press the ENTER key.**
The black circle (●) indicates the currently selected display language.

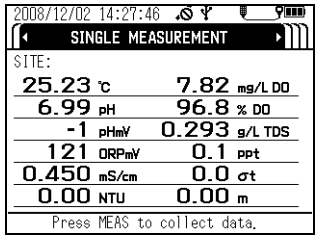


FOR BIDDING PURPOSES ONLY

● Version

Follow the steps below to display the program No. and version of the control unit and sensor probe software.
The program No. and version of the sensor probe software will not be displayed if the sensor probe is not connected.

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
The "MEASUREMENT" screen appears after about 10 seconds.

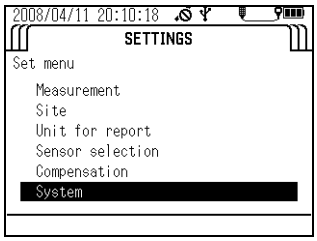


Note

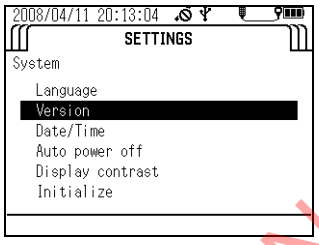
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**

3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Version", then press the ENTER key.**
   The program No. of the control unit and sensor probe software appears.

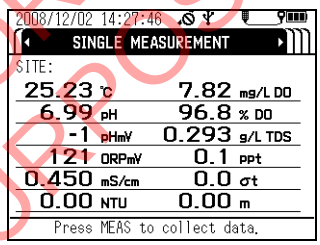


FOR BIDDING PURPOSES ONLY

● Setting the date/time

Follow the steps below to set the date and time.

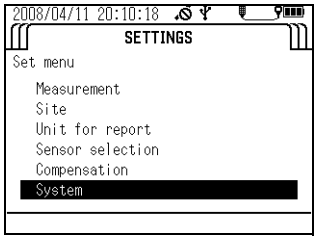
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



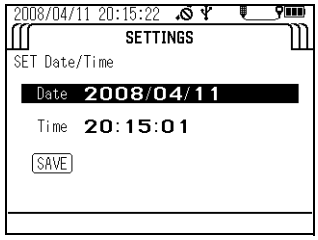
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

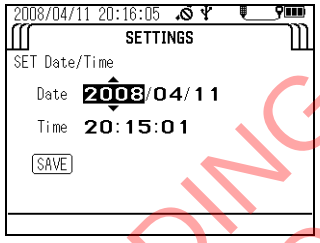
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



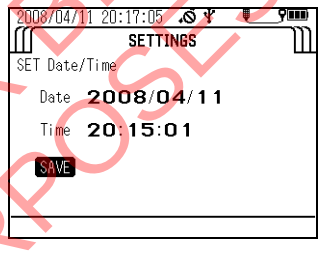
4. **Press the down (▽) key to move the cursor to "Date/time", then press the ENTER key.**



5. **Move the cursor to the date, then press the ENTER key.**
6. **Press the right (▷) key to move the cursor to the year, month, day, hour, minute and second, and press the up (△) and down (▽) keys to enter each value.**



7. **When finished entering settings, press the ENTER key to move the cursor to SAVE, then press the ENTER key again to save the settings.**

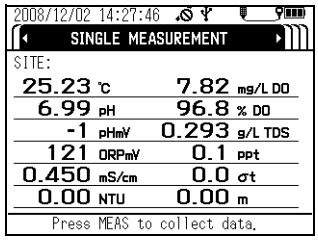


FOR BIDDING PURPOSES ONLY

● Setting the auto power OFF time

Follow the steps below to set the time for the auto power OFF function (which turns the power OFF automatically when no operation is performed for the preset amount of time).

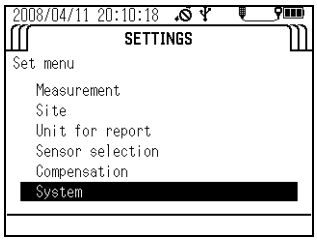
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



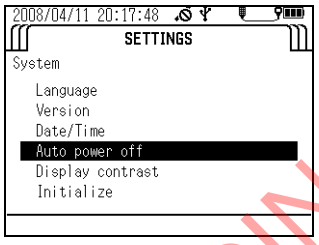
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

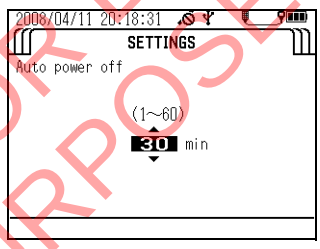
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Auto power off", then press the ENTER key.**



5. **Press the up (△) and down (▽) keys to select the desired time setting, then press the ENTER key.**
   You can select OFF, or settings of 1, 2, 5, 10, 20, 30 or 60 minutes.
   Default: 30 minutes

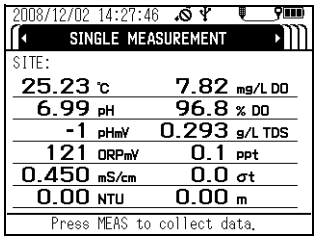


FOR BIDDING PURPOSES ONLY

● Display contrast

Follow the steps below to adjust the display's contrast.

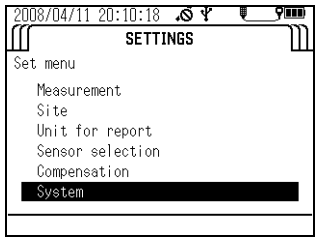
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



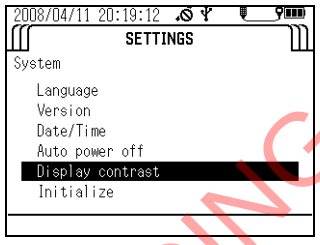
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

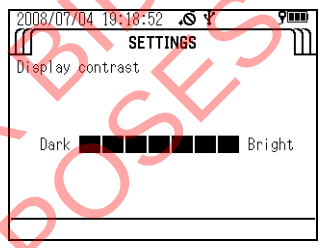
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



4. **Press the down (▽) key to move the cursor to "Display contrast", then press the ENTER key.**



5. **Press the left (◁) and right (▷) keys to adjust the contrast.**
   Adjustment can be made in 26 steps.



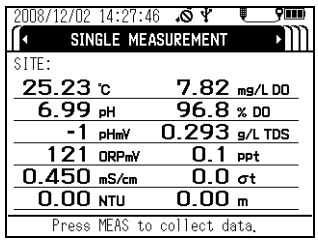
6. **Press the ENTER key.**

FOR BIDDING PURPOSES ONLY

● Initialization

Follow the steps below to restore all the settings except date/time to their factory defaults. Factory default calibration data for the electrical conductivity and turbidity sensors will also be deleted at the same time.

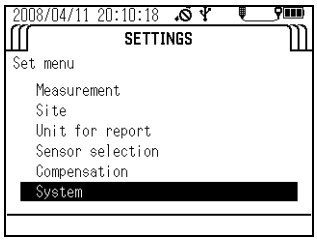
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



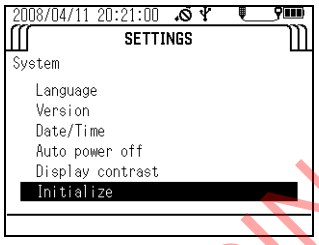
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

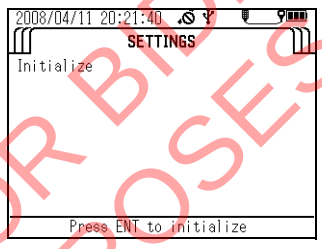
2. **Press the right (▷) key to switch the display to the "SETTINGS" screen.**
3. **Press the down (▽) key to move the cursor to "System", then press the ENTER key.**



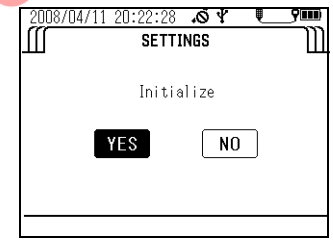
4. **Press the down (▽) key to move the cursor to "Initialize", then press the ENTER key.**



5. **Press the ENTER key again.**



6. **A confirmation message appears asking whether to execute initialization. Press the left (◁) key to move the cursor to YES, then press the ENTER key.**
   The message "Initialize Complete" appears to indicate the process has finished.



FOR BIDDING PURPOSES ONLY

3.3 Calibration

To obtain correct measurement values, the sensors need to be calibrated using standard solution before measurement. You can select simultaneous auto calibration of the pH, COND and TURB sensors in pH4 standard solution and DO and DEP sensors simultaneously in air, or manual calibration of individual measurement parameters. You can check the result of the previous calibration using the procedure on “ 3.5.4 Checking the calibration record ” (page 70).

Note

- **Wait at least 20 minutes after turning the system power ON before calibrating the DO sensor.**
- **Make the DO and COND compensation settings before calibration since these settings are applied during calibration.**
- **You can select only the desired parameters for calibration and calibrate just those parameters (see “ 3.2.4 Sensor selection ” (page 25)).**
- **Use about 200 mL of standard solution in the calibration cup.**
- **Calibration data is stored in the sensor probe.**

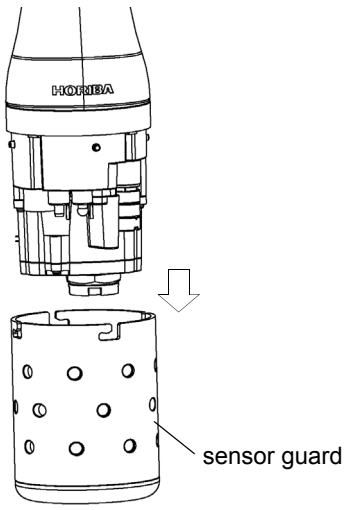
3.3.1 Auto calibration

Tip

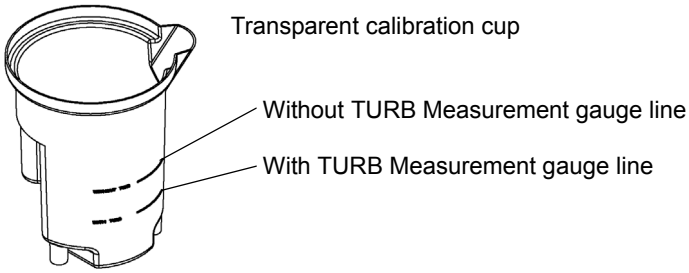
- **The following parameters are calibrated (at 25°C):**
  pH: Set to 4.01 (zero-point calibration); the span is adjusted to the factory default value.
  COND: 0.449 S/m (4.49 mS/cm, span calibration); the zero point is adjusted to the factory default value.
  TURB: 0 NTU (zero-point calibration); the span is adjusted to the factory default value.
  DO: 8.92 mg/L (span calibration); the zero point is adjusted to the factory default value.
  DEP: 0 m (zero-point calibration); the zero point is adjusted to the factory default value.
- **If the air temperature changes, the readout value may not be stable. Ensure that the ambient air temperature is the same temperature as the calibration solution, because the internal probe temperature sensor and external temperature sensor (in the calibration solution) are used for the auto calibration. Allow the probe and standard solution to equilibrate for 1 hour if a thermometer is not available to verify that these temperatures are the same.**
- **Do not hold the probe while performing the auto calibration. Body temperature may elevate the internal temperature sensor measurement creating DO calibration error.**

FOR BIDDING PURPOSES ONLY

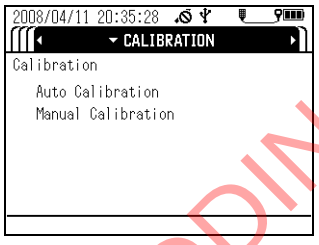
1. **Remove the sensor guard and wash the sensor probe 2 or 3 times with deionized water.**



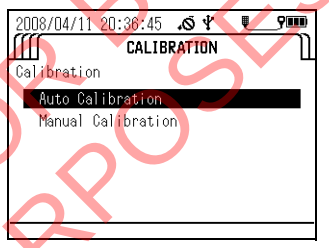
2. **Remove the transparent calibration cup.**
3. **Fill the transparent calibration cup to the line with pH 4 standard solution.**
   The transparent calibration cup has With TURB Measurement and Without TURB Measurement gauge lines.



4. **Press the control unit's CAL key to set the calibration mode.**

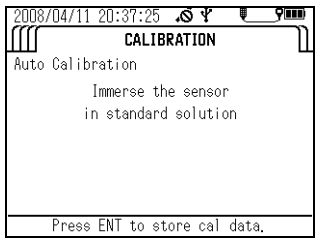


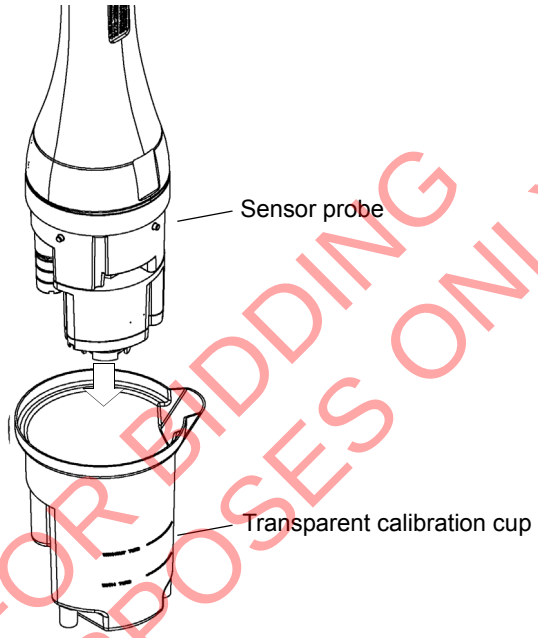
5. **Press the down (▽) key to move the cursor to "Auto Calibration", then press the ENTER key.**



FOR BIDDING PURPOSES ONLY

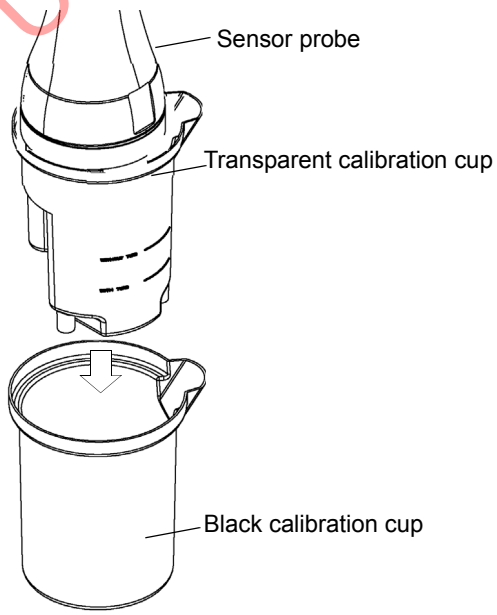
6. **Immerse the sensor probe in the transparent calibration cup.**
   Check that the pH sensor, ORP sensor, reference electrode, COND sensor, TURB sensor and temperature sensor are submerged in the pH 4 standard solution and check that there are no air bubbles on the sensor.





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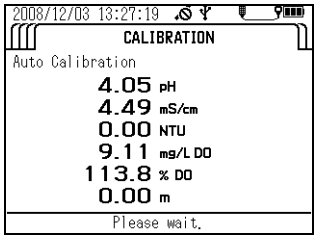
7. **With the sensor probe still in the transparent calibration cup, place the transparent calibration cup into the black calibration cup.**



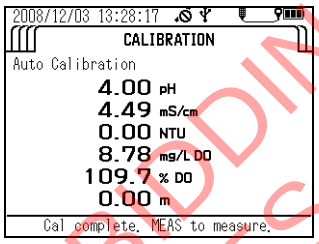
8. **When all the sensor values have stabilized, press the ENTER key to start calibration.**

Note

Do not remove the sensor probe from the calibration solution. U-53 turbidity data will display "----" until the calibration is completed.



Calibration is finished when the message "Cal complete. MEAS to measure." appears. Press the MEAS key to set the measurement screen, then start measurement.



If a calibration error occurs, start calibration after first resolving the issue according to the instructions in " 4.6 Troubleshooting " (page 89).

FOR BIDDING PURPOSES ONLY

3.3.2 Manual calibration

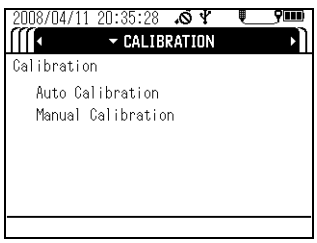
The procedures below describe how to calibrate each sensor individually.

Note

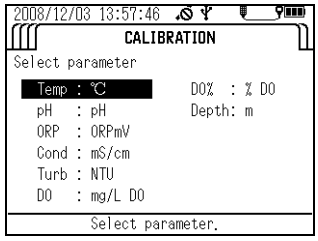
The displayed units are the units set by selecting "Unit for report" in the "SETTINGS" screen.

● **Temperature (TEMP) calibration**

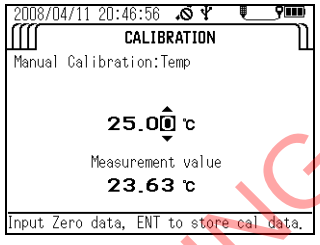
1. **Fill a bucket or similar container with water of a known temperature, and insert the sensor probe in it.**
   Wait 5 minutes before starting calibration to allow the sensor probe temperature to stabilize.
2. **Press the control unit's CAL key to set the calibration mode.**
3. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



4. **In the parameter selection screen, move the cursor to “Temp”, then press the ENTER key.**



5. **Press the up (△) and down (▽) keys to set the calibration value - the temperature of the water containing the submerged sensor probe.**



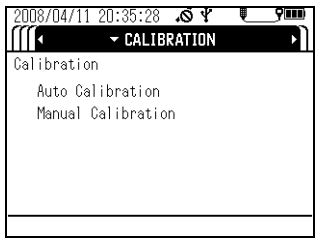
6. **Check that “Measurement value” has stabilized, then press the ENTER key to start calibration.**
   Calibration is finished when the message “Cal complete. CNT to measure.” appears.

● pH calibration

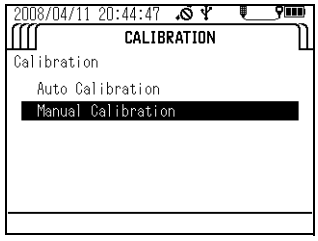
Note

You can select one calibration point (zero-point calibration) or two calibration points (zero-point calibration and span calibration). Carry out two calibration procedures to ensure good measurement precision throughout all measurement ranges.

1. **Calibrate the zero point. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with pH 7 standard solution.**
2. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
3. **Press the control unit’s CAL key to set the calibration mode.**

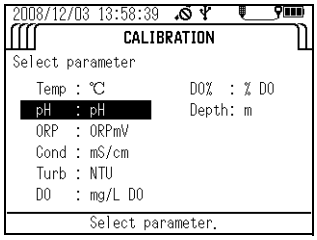


4. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**

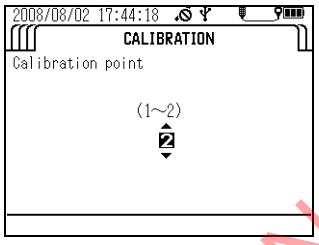


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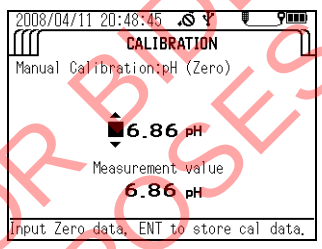
5. **In the parameter selection screen, move the cursor to "pH", then press the ENTER key.**



6. **Set the number of calibration points, then press the ENTER key.**



7. **Press the up (△) and down (▽) keys to set the pH value of the pH 7 standard solution containing the submerged sensor probe at the measurement temperature**

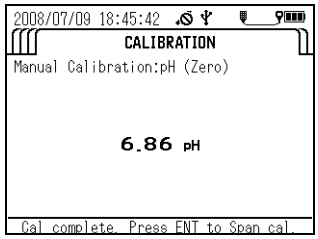


FOR BIDDING PURPOSES ONLY

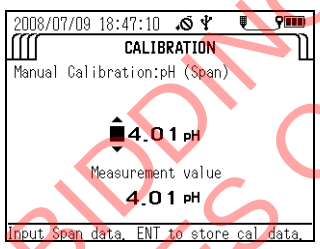
Temp. (°C)	pH 4 standard solution Phthalate	pH 7 standard solution Neutral phosphate	pH 9 standard solution Borate
0	4.01	6.98	9.46
5	4.01	6.95	9.39
10	4.00	6.92	9.33
15	4.00	6.90	9.27
20	4.00	6.88	9.22
25	4.01	6.86	9.18
30	4.01	6.85	9.14
35	4.02	6.84	9.10
40	4.03	6.84	9.07
45	4.04	6.84	9.04

8. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

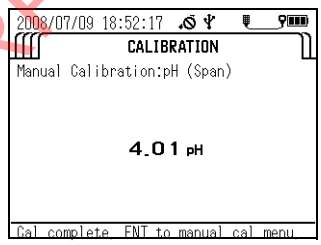
9. **Press the ENTER key to start the span calibration procedure when the message "Cal complete. Press ENT to Span cal." appears.**



10. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with pH 4 or pH 9 standard solution.**
11. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
12. **Press the up (△) and down (▽) keys to set the pH value of the pH 4 or pH 9 standard solution containing the submerged sensor probe at the measurement temperature.**



13. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
14. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter**



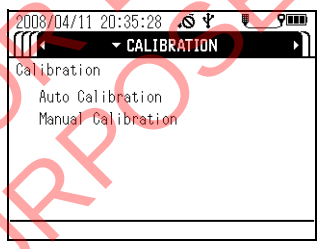
FOR BIDDING PURPOSES ONLY

● ORP calibration

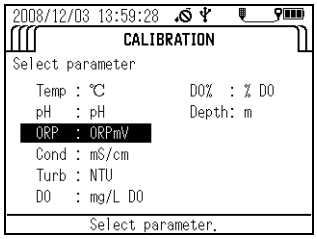
Note

- **If the prepared ORP standard solution is left in open air for one hour or more, the solution may be transformed. For this reason ORP standard solution cannot be stored.**
  Calibrate within one hour of preparing the solution.
- **When measuring sample with low concentrations of oxidants and reductants after conducting an operational check using a standard substance, the measured values may not stabilize or the results of measurement might not be repeatable. If this is the case, start the measurement after immersing the sensors in the sample water sufficiently.**
- **Note that when measuring the ORP of solution with extremely low concentrations of oxidants and reductants, such as tap water, well water, or water treated with purifying equipment, there may be less responsiveness, repeatability, and stability, in general.**
- **When alkaline ion water is left for 5 minutes, its ORP undergoes changes significantly. Always measure alkaline ion water promptly.**

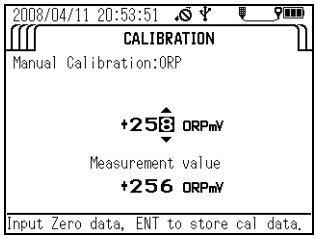
1. **Fill a clean beaker with one bag of ORP standard powder No. 160-22 or No. 160-51. Add 250 mL of deionized water and agitate the solution thoroughly (there will be some excess quinhydrone (a black powder) that floats on the surface when agitating the solution). Fill the transparent calibration cup to the reference line with this standard solution.**
2. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
3. **Press the control unit's CAL key to set the calibration mode.**
4. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



5. **In the parameter selection screen, move the cursor to ORP, then press the ENTER key.**



6. **Press the up (△) and down (▽) keys to set the mV value of the ORP standard solution containing the submerged sensor probe at the measurement temperature.**



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Table 1 Indicated value of ORP standard solution at various temperatures (mV)

Temperature	160-22	16051
5	+274	+112
10	+271	+107
15	+267	+101
20	+263	+95
25	+258	+89
30	+254	+83
35	+249	+76
40	+244	+69

7. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
8. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**

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Conductivity (COND) calibration

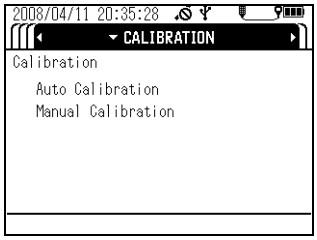
Note

- **To support a wide range of sample concentrations, electrical conductivity is divided into three measurement ranges: 0.0 mS/m to 99.9 mS/m, 0.090 S/m to 0.999 S/m, and 0.9 S/m to 9.99 S/m.**
- **When manually calibrating conductivity, you can select two calibration points (one zero-point calibration point and a span calibration point for one of the three measurement ranges) or four calibration points (one zero-point calibration point and span calibration points for all three measurement ranges). Carry out the four calibration points to ensure good measurement precision throughout all measurement ranges.**
- **Make the compensation setting before calibration since this setting is applied during calibration. (Refer to " 6.5.3 Temperature coefficient " (page 104)).**

1. **Prepare the standard solution. Dry Potassium chloride (KCl) powder (high-grade commercially available) at 105°C for two hours, and leave it to cool in a desiccator.**
2. **Consult the following table and weigh potassium chloride (KCl), then prepare three standard potassium chloride (KCl) solutions following the procedure below.**

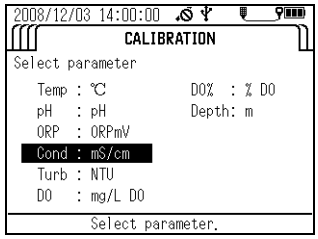
Potassium chloride (KCl) standard solution	Conductivity (COND) value	Potassium chloride (KCl) mass (g) at solution temperature of 25 °C	Calibration range
0.005 mol/L	71.8 mS/m (0.718 mS/cm)	0.373	0.0 mS/m to 99.9 mS/m (0.00 mS/cm to 0.999 mS/cm)
0.050 mol/L	0.667 S/m (6.67 mS/cm)	3.73	0.090 S/m to 0.999 S/m (1.00 mS/cm to 9.99 mS/cm)
0.500 mol/L	5.87 S/m (58.7 mS/cm)	37.2	0.9 S/m to 9.99 S/m (10.0 mS/cm to 99.9 mS/cm)

3. **Dissolve the weighed Potassium Chloride (KCl) in deionized water.**
4. **Put the dissolved Potassium Chloride (KCl) into a 1 L measuring flask, and fill to the 1 L mark with deionized water.**
5. **Calibrate the zero point. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then remove all moisture from the sensor probe (it will be calibrated in air).**
6. **Press the control unit's CAL key to set the calibration mode.**
7. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**

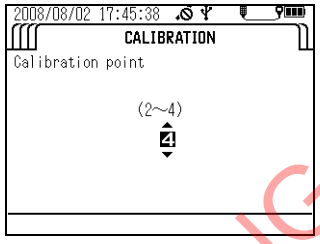


FOR BIDDING PURPOSES ONLY

8. **In the parameter selection screen, move the cursor to “Cond”, then press the ENTER key.**

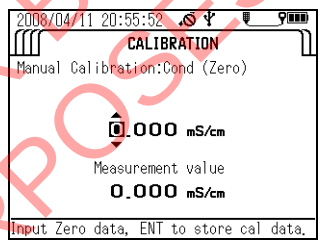


9. **Set the number of calibration points, then press the ENTER key.**

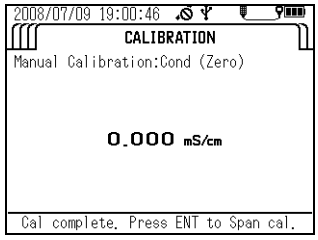


The instructions below assume that four calibration points have been set.

10. **Press the up (△) and down (▽) keys to set the "Cond" value to 0.0 mS/m (0.000 mS/cm).**
11. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**



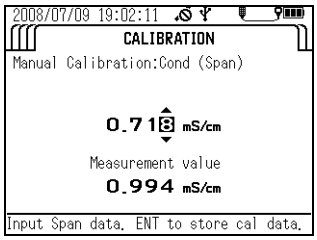
12. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the first span calibration procedure.**



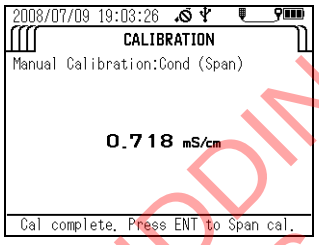
13. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 71.8 mS/m (0.718 mS/cm) standard solution.**
14. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

FOR BIDDING PURPOSES ONLY

15. **Press the up (△) and down (▽) keys to set the "Cond" value to 71.8 mS/m (0.718 mS/cm).**
    Calibration range = 0 mS/m to 99.9 mS/m (0 mS/cm to 0.999 mS/cm)

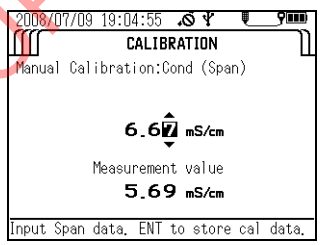


16. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
17. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**

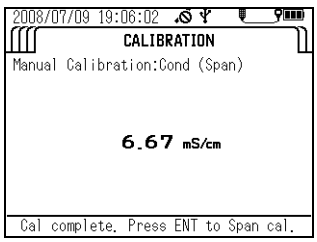


FOR BIDDING PURPOSES ONLY

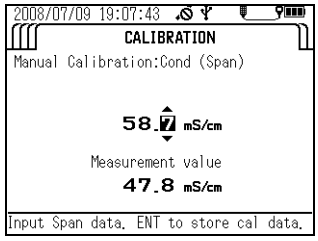
18. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 0.667 S/m (6.67 mS/cm) standard solution.**
19. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
20. **Press the up (△) and down (▽) keys to set the "Cond" value to 0.667 S/m (6.67 mS/cm).**
    Calibration range = 0.100 S/m to 0.999 S/m (1.00 mS/cm to 9.99 mS/cm)



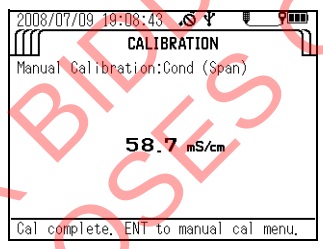
21. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
22. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**



23. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 5.87 S/m (58.7 mS/cm) standard solution.**
24. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
25. **Press the up (△) and down (▽) keys to set the "Cond" value to 5.87 S/m (58.7 mS/cm).**
    Calibration range = 1.00 S/m to 10.00 S/m(10.0 mS/cm to 100.0 mS/cm)



26. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
27. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**



FOR BIDDING PURPOSES ONLY

● Turbidity (TURB) calibration

Note

- **To support a wide range of sample concentrations, turbidity is divided into three measurement ranges: 0.0 to 9.9 NTU, 10 to 100 NTU, and over 100 NTU.**
- **When manually calibrating turbidity, you can select two calibration procedures (one zero-point calibration procedure and a span calibration procedure for one of the three measurement ranges), three calibration procedures (one zero-point calibration procedure and a span calibration procedure for two of the three measurement ranges) or four calibration procedures (one zero-point calibration procedure and span calibration procedures for all three measurement ranges). Carry out the four calibration procedures to ensure good measurement precision throughout all measurement ranges.**
- **Always use the calibration cup provided. Using other containers can create effects from ambient light that cause incorrect calibration.**

● Preparing the standard solutions

1. **Weigh out 5.0 g of hydrazine sulfate (commercial special grade or above), and dissolve it in 400 mL of deionized water. Dissolve 50 g of hexamethylene tetramine (commercial special grade or above) in 400 mL of deionized water in anther flask.**
2. **Mix the two solutions and add deionized water until the total solution volume is 1000 mL, and mix well. Store this solution at a temperature of 25°C ±3°C for 48 hours.**
   The turbidity value (TURB) of this solution is equivalent to 4000 NTU.
3. **Dilute 4000 NTU-solution 5 times (use a pipette to measure 50 mL of the 4000 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)**
   The turbidity value (TURB) of this solution is equivalent to 800 NTU.
4. **Dilute 800 NTU solution 10 times (use a pipette to measure 25 mL of the 800 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)**
   The turbidity value (TURB) of this solution is equivalent to 80 NTU.
5. **Dilute 80 NTU solution 10 times (use a pipette to measure 25 mL of the 80 NTU solution and pour it into a 250 mL measuring flask, and fill up to 250 mL meniscus)**
   The turbidity value (TURB) of this solution is equivalent to 8 NTU.

Note

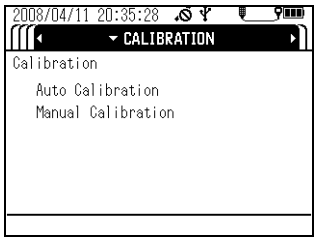
Instead of the standard solutions above, you can use other standard solutions of known concentration measured with other standard instruments.

● U-52, U-53 turbidity calibration

Set the number of calibration points.

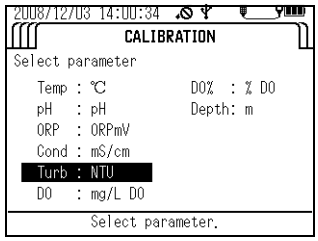
You can set between 2 and 4 points.

1. **Press the control unit's CAL key to set the calibration mode.**
2. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**

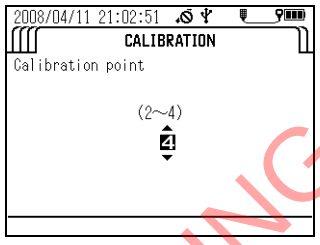


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3. **In the parameter selection screen, move the cursor to "Turb", then press the ENTER key.**

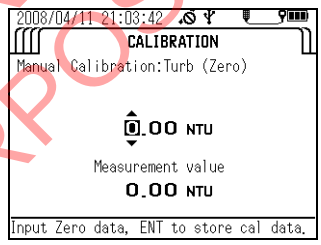


4. **Press the up (△) and down (▽) keys to set the number of calibration points, then press the ENTER key.**

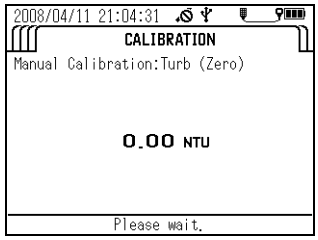


The instructions below assume that four calibration points have been set.

5. **Calibrate the zero point. Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with deionized water.**
6. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
7. **Press the up (△) and down (▽) keys to set the "Turb" value to 0.0 NTU.**

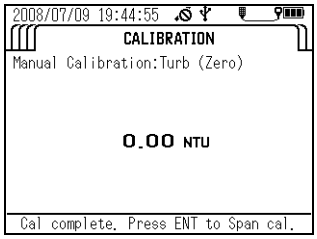


8. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**

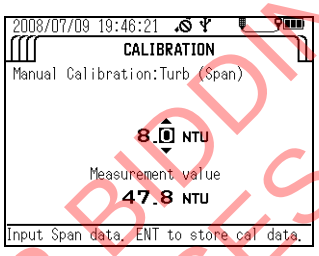


FOR BIDDING PURPOSES ONLY

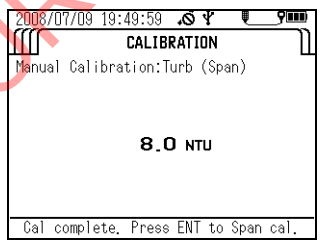
9. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the first span calibration procedure.**



10. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 8 NTU standard solution, or a standard solution of known concentration between 0.1 and 10 NTU.**
11. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
12. **Press the up (△) and down (▽) keys to set the "TURB" value to 8 NTU, or to the known concentration of the standard solution between 0.1 and 10 NTU. (Input range = 0 NTU to 9.9 NTU (U-51) or 0 NTU to 9.99 NTU (U-52))**



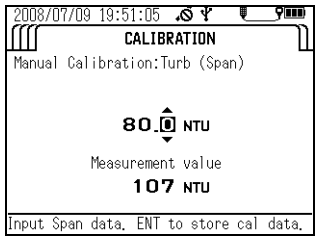
13. **Check that "Current measurement value" has stabilized, then press the ENTER key to start calibration.**
14. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**



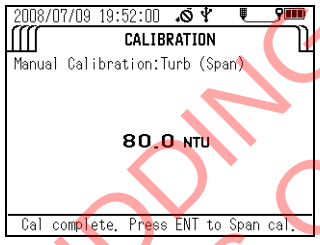
15. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 80 NTU standard solution, or a standard solution of known concentration between 10 and 100 NTU.**
16. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**

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17. **Press the up (△) and down (▽) keys to set the "Turb" value to 80 NTU, or to the known concentration of the standard solution between 10 and 100 NTU. (Input range = 10.0 NTU to 99.9 NTU)**

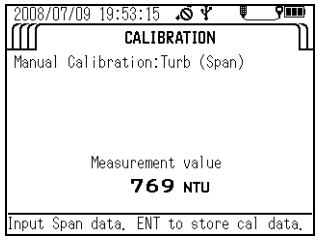


18. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
19. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the next span calibration procedure.**

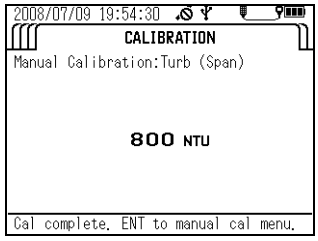


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20. **Wash the transparent calibration cup 2 or 3 times with deionized water, then fill it to the reference line with 800 NTU standard solution, or a standard solution of known concentration 100 NTU above.**
21. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the transparent calibration cup.**
22. **Press the up (△) and down (▽) keys to set the "TURB" value to 800 NTU, or to the known concentration of the standard solution 100 NTU above.**
(Input range = 100 NTU to 800 NTU (U-51), 100 NTU to 1000 NTU (U-52))



23. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
24. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**

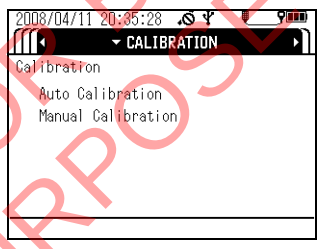


● Dissolved oxygen (DO) calibration

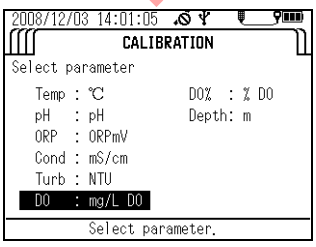
Note

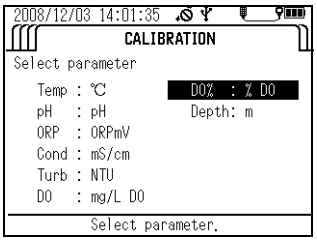
- **You can select one calibration procedure (span calibration) or two calibration procedures (zero-point calibration and span calibration). Carry out the two calibration procedures to ensure good measurement precision throughout all measurement ranges.**
- **It is necessary to prepare new solution before calibration of the Dissolved Oxygen (DO) sensor.**
- **The calibration cup (included) cannot be used to manually calibrate the DO sensor. Use a suitable bottle in which the DO sensor and the temperature sensor can be immersed.**
- **Wait at least 20 minutes after turning the system power ON before calibrating the DO sensor.**
- **Make the compensation setting before calibration since the setting is applied during calibration.**
- **The DO sensor is affected by flow. When performing span calibration with saturated dissolved oxygen water, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) or agitate the saturated dissolved oxygen water.**

1. **Prepare the standard solution.**
   - Add about 50 g of sodium sulfite to 1000 mL of water (either deionized water or tap water) and stir the mixture to dissolve the sodium sulfite in it.
   - Pour 1 to 2 liters of water into a suitable flask (either deionized water or tap water). Using a air pump, feed air into the water and aerate the solution until oxygen is saturated.
2. **First, calibrate the zero point. Press the control unit's CAL key to set the calibration mode.**
3. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**

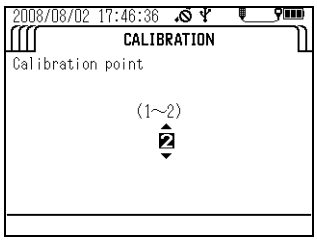


4. **In the parameter selection screen, move the cursor to DO or DO%, then press the ENTER key.**





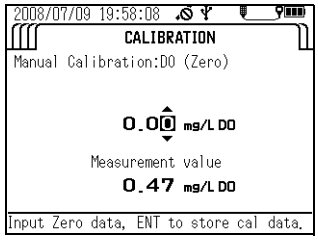
5. **Set the number of calibration procedures, then press the ENTER key.**

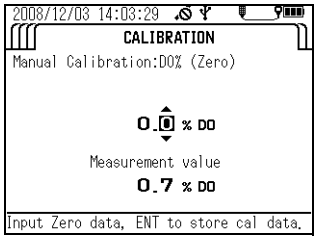


The instructions below assume that two calibration points have been set.

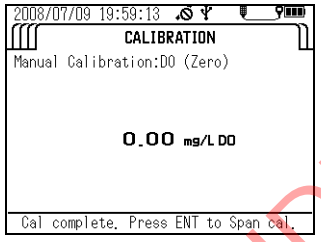
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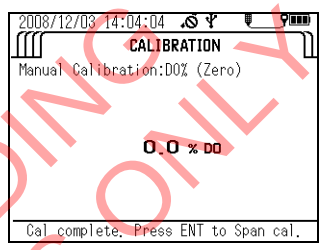
6. **Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then submerge the sensor probe in the bottle.**
7. **Press the up (△) and down (▽) keys to set the DO value to 0.00 mg/L or 0.0%.**



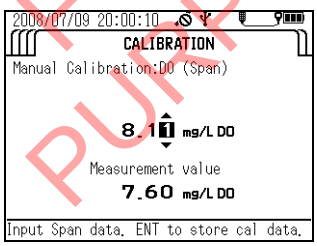


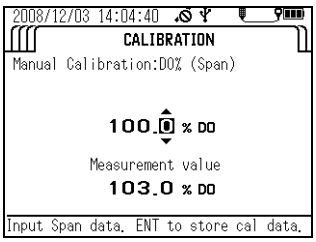
8. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
9. **When the message "Cal complete. Press ENT to Span cal." appears, press the ENTER key to start the span calibration procedure.**



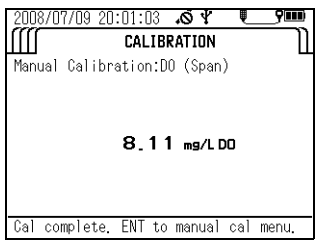


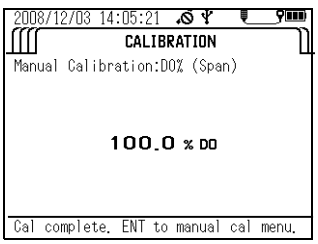
10. **Wash the sensor probe 2 or 3 times with deionized water to remove any dirt, then submerge the sensor probe in the container filled with the span solution.**
11. **Press the up (△) and down (▽) keys to set the DO value to the saturated dissolved oxygen value (mg/L) of the water at that temperature or the dissolved oxygen saturation ratio.**





12. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**
13. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**





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Amounts of saturated dissolved oxygen in water at various temperatures (salinity=0.0%)

JIS K0101

Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.16						
1	13.77	11	10.67	21	8.68	31	7.42
2	13.40	12	10.43	22	8.53	32	7.32
3	13.04	13	10.20	23	8.39	33	7.22
4	12.70	14	9.97	24	8.25	34	7.13
5	12.37	15	9.76	25	8.11	35	7.04
6	12.06	16	9.56	26	7.99	36	6.94
7	11.75	17	9.37	27	7.87	37	6.86
8	11.47	18	9.18	28	7.75	38	6.76
9	11.19	19	9.01	29	7.64	39	6.68
10	10.92	20	8.84	30	7.53	40	6.59

ISO5814

Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	14.62				
1	14.22	11	11.03	21	8.91
2	13.83	12	10.78	22	8.74
3	13.46	13	10.54	23	8.58
4	13.11	14	10.31	24	8.42
5	12.77	15	10.08	25	8.26
6	12.45	16	9.87	26	8.11
7	12.14	17	9.66	27	7.97
8	11.84	18	9.47	28	7.83
9	11.56	19	9.28	29	7.69
10	11.29	20	9.09	30	7.56

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● Span setting values for calibration in air

The software should display these values when auto calibration is performed.
Use this table to input values for manual span calibrations in air.

Tip

The DO measurement value of "air-saturated water" and air are different.
Due to the pressure difference against the membrane in air versus the membrane in water, the measurement value in air is about 10% higher than the value of air-saturated water on average.

Amounts of saturated dissolved oxygen in air at various temperatures

Following tables are applicable only to the air calibration of the U-50 DO sensor. Do not use them for other purpose.

Air calibration value in adopting evaluation based on JIS K0101

Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)	Temp (°C)	DO (mg/L)
0	15.58						
1	15.15	11	11.74	21	9.55	31	8.16
2	14.74	12	11.47	22	9.38	32	8.05
3	14.34	13	11.22	23	9.23	33	7.94
4	13.97	14	10.97	24	9.08	34	7.84
5	13.61	15	10.74	25	8.92	35	7.74
6	13.27	16	10.52	26	8.79	36	7.63
7	12.93	17	10.31	27	8.66	37	7.55
8	12.62	18	10.10	28	8.53	38	7.44
9	12.31	19	9.91	29	8.40	39	7.35
10	12.01	20	9.72	30	8.28	40	7.25

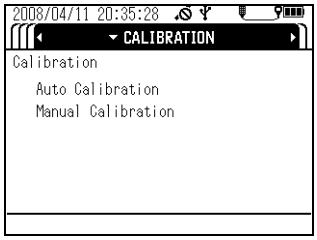
FOR BIDDING PURPOSES ONLY

Air calibration value in adopting evaluation based on ISO5814

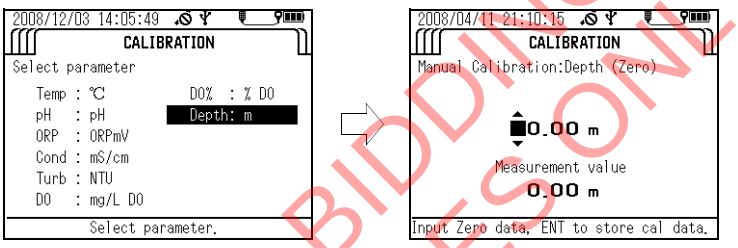
Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)	Temp. (°C)	DO (mg/L)
0	16.08				
1	15.64	11	12.13	21	9.80
2	15.21	12	11.86	22	9.61
3	14.81	13	11.59	23	9.44
4	14.42	14	11.34	24	9.26
5	14.05	15	11.09	25	9.09
6	13.70	16	10.86	26	8.92
7	13.35	17	10.63	27	8.77
8	13.02	18	10.42	28	8.61
9	12.72	19	10.21	29	8.46
10	12.42	20	10.00	30	8.32

● Water depth (DEPTH) calibration

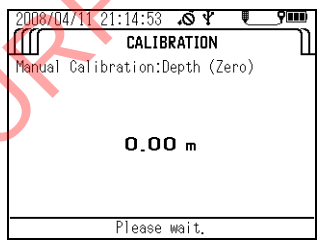
1. **Calibrate the zero point. Wash the sensor probe 2 or 3 times in deionized water to remove any dirt, then remove all moisture from the sensor probe (it will be calibrated in air).**
2. **Press the control unit's CAL key to set the calibration mode.**
3. **Press the down (▽) key to move the cursor to "Manual Calibration", then press the ENTER key.**



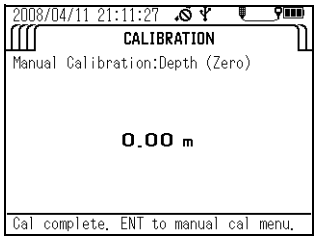
4. **In the parameter selection screen, move the cursor to "Depth", then press the ENTER key.**



5. **Press the up (△) and down (▽) keys to set the "Depth" value to 0.00 m.**
6. **Check that "Measurement value" has stabilized, then press the ENTER key to start calibration.**



7. **Calibration is finished when the message "Cal complete. ENT to manual cal menu." appears. Press the ENTER key to return to the calibration parameter selection screen.**



FOR BIDDING PURPOSES ONLY

3.4 Measurement

You can perform measurement by either of the methods below.

- Storing data in memory manually with reference to the measurement value (single measurement)
- Having data stored in memory automatically and continuously
  U-51/U-52: Interval measurement (minimum memory interval of 10 seconds)
  U-53: Interval measurement (minimum memory interval of 30 seconds)

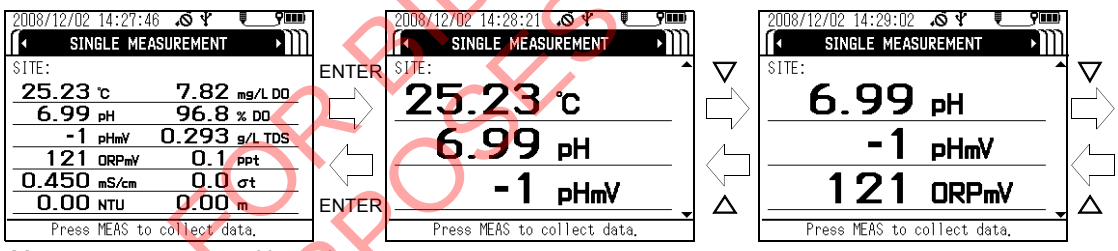
Select the measurement method that meets your requirements.

Note

- **Lower sensor probe slowly when submerging them in samples.**
- **Sensors may break if sensor probe are dropped from a height of 1 meter or more.**
- **Do not submerge sensor probe in water depths of over 30 meters. Sensor probe are only resistant to water pressure of up to 30 meters.**
- **After turning the power ON, check that the DO readout value has stabilized before starting measurement (takes around 20 minutes).**

Tip

- **When on the measurement screen, pressing the ENTER key enlarges the display and shows three measured values at a time.**
- **Pressing the up (△) and down (▽) keys scrolls through the measured values one item at a time.**
- **Pressing the ENTER key again reverts to the normal measurement screen display.**



Measurement screen Normal Enlarged

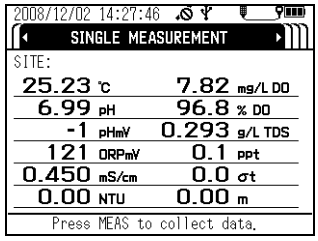
FOR BIDDING PURPOSES ONLY

3.4.1 Storing data in memory manually

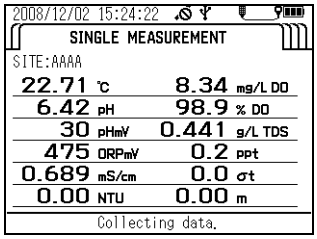
Follow the steps below to manually store data in memory while referring to the measurement value to check the readout value is stable.

● **U-51/U-52**

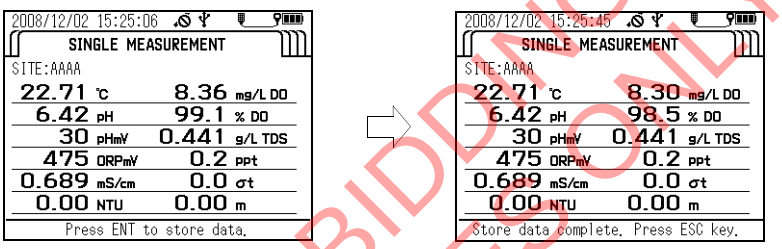
1. **Check that each sensor and sensor guard is mounted.**
2. **Check that "SINGLE MEASUREMENT" has been selected in the measurement screen.**



3. **Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.**
   If the sample is non-flowing, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) to ensure that fresh sample is continuously supplied to the DO sensor.
4. **When the measurement values are stable, press the MEAS key to acquire the 5-second average.**



5. **Press the ENTER key to save the held measurement values, or press the ESC key to cancel the operation.**



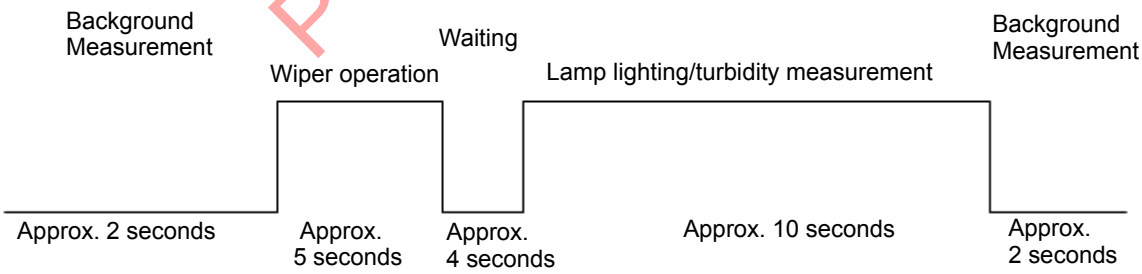
FOR BIDDING PURPOSES ONLY

● U-53

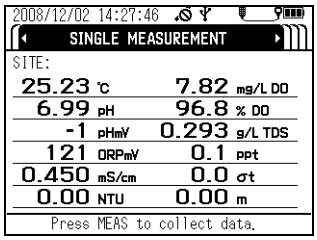
Note

Do not perform turbidity measurement in air as it may damage the wiper.

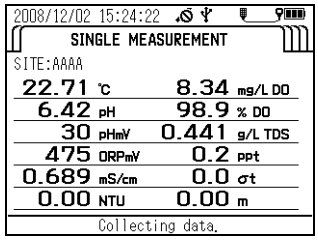
U-53 turbidity measurement follows the sequence below. The measurement values are held after each sequence.



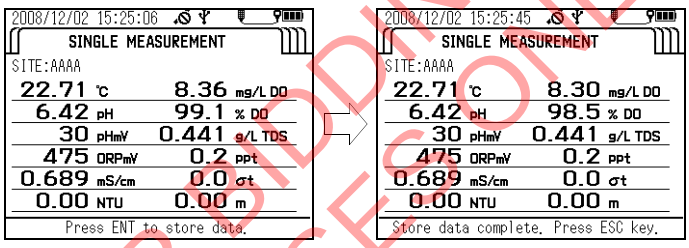
1. **Check that each sensor and sensor guard is mounted.**
2. **Check that "SINGLE MEASUREMENT" has been selected in the measurement screen.**



3. **Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.**
   If the sample is non-flowing, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) to ensure that fresh sample is continuously supplied to the DO sensor.
4. **When the non-turbidity meter measurement values are stable, press the MEAS key to start the sequence above.**



5. **When the sequence has finished, hold the measurement values. Press the ENTER key to store the held measurement values, or press the ESC key to cancel the operation.**

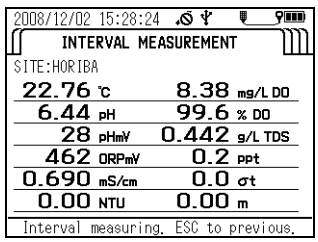


FOR BIDDING PURPOSES ONLY

3.4.2 Automatic, continuous measurement

● **Interval measurement**

1. **Select the "Interval measurement" measurement setting (see " 3.2.1 Setting measurement methods " (page 18)).**
2. **Press the up (△) and down (▽) keys to set the interval value to the desired value (U-51/U-52: minimum interval: 10 seconds, U-53: minimum interval: 30 seconds), then press the ENTER key.**
   The measurement screen appears automatically, and the system becomes ready for measurement.
3. **Check that each sensor and sensor guard is mounted.**
4. **Submerge the sensor probe in the sample, gently shaking them in the sample to remove any air bubbles from the sensors.**
   If the sample is non-flowing, move the cable slowly up and down (move the sensor probe at a rate of roughly 20 to 30 cm a second) to ensure that fresh sample is continuously supplied to the DO sensor.
5. **Press the ENTER key to start measurement.**



3.5 Data operations

Use the procedures below to retrieve data stored in memory, delete all the data, check the remaining data memory capacity, and check the calibration record.

3.5.1 Displaying data

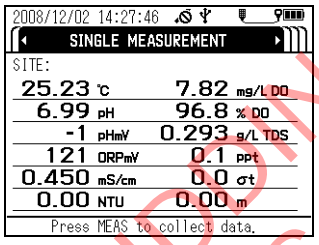
For maximum efficiency, there are 3 methods of displaying data.

- Displaying the data for a specified site
- Displaying the data for a specified date/time
- Displaying all the data

Use the method that best suits your requirements.

● **Displaying the data for a specified site**

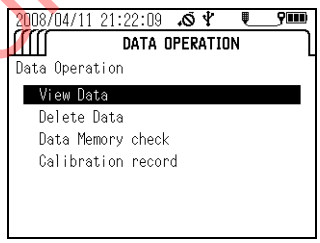
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



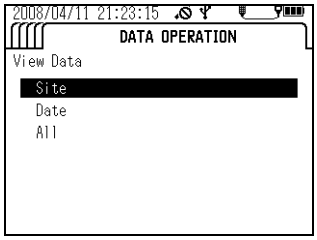
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "View Data", then press the ENTER key.**



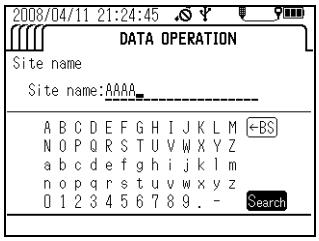
4. **Move the cursor to "Site", then press the ENTER key.**



5. **Press the up (△), down (▽), left (◁) and right (▷) keys to enter the site to retrieve.**

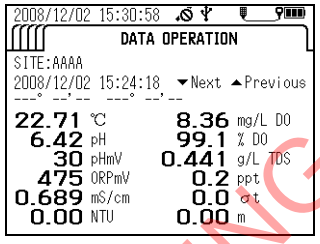
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6. **Move the cursor to "Search", then press the ENTER key.**



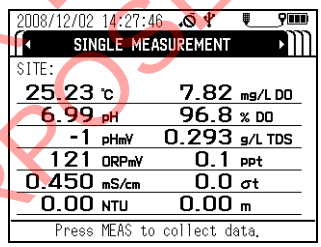
All site names that begin with the entered text are displayed.
The most recently measured data for the entered site is displayed.

7. **Press the up (△) and down (▽) keys to display earlier data.**



● Displaying the data for a specified date/time

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.

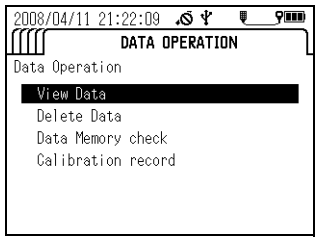


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Note

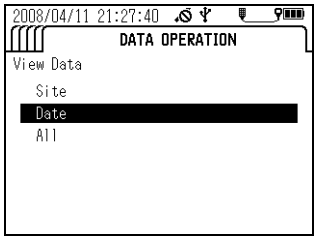
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "View Data", then press the ENTER key.**



4. **Move the cursor to "Date", then press the ENTER key.**

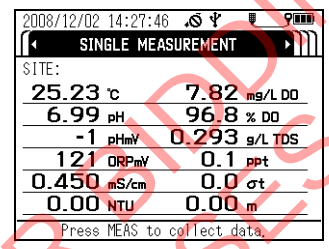
5. **With the cursor on the Date, press the ENTER key.**



6. **Press the up (△), down (▽), left (◁) and right (▷) keys to enter the desired date/time, then press the ENTER key to apply the setting.**
7. **The cursor moves to "Search". Press the ENTER key to start the search.**
8. **Press the up (△) and down (▽) keys to display earlier data.**

● Displaying all the data

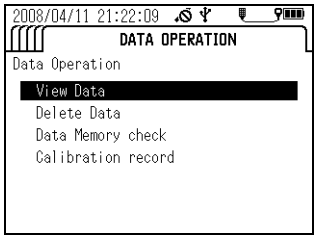
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



Note

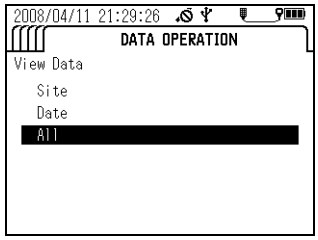
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "View Data", then press the ENTER key.**



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4. **Move the cursor to "All", then press the ENTER key.**
The most recently measured data is displayed.



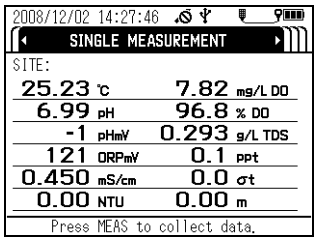
5. **Press the up (△) and down (▽) keys to display earlier data.**

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3.5.2 Deleting data

Follow the steps below to delete all the data stored in memory.

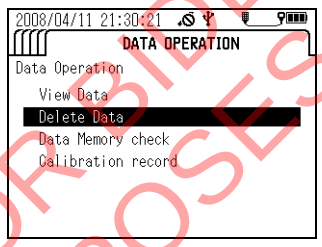
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



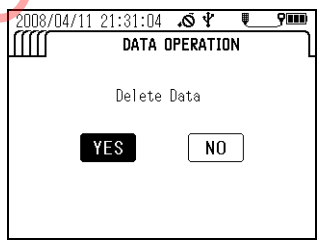
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "Delete Data", then press the ENTER key.**



4. **Press the left (◁) key to move the cursor to YES, then press the ENTER key.**
   All the data has been deleted when the indicator appears along with the message "No data exists".

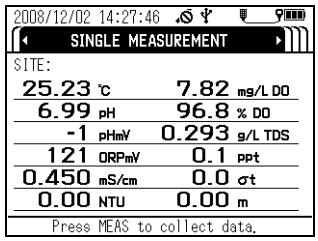


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3.5.3 Checking the data memory

You can check the used data capacity and the remaining data capacity.

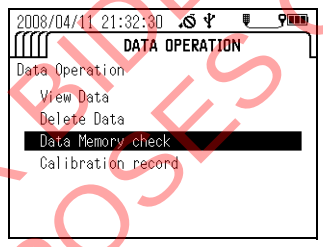
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



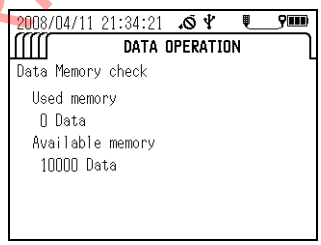
Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "Data Memory Check", then press the ENTER key.**



The amount of memory in use and amount of available memory are displayed.

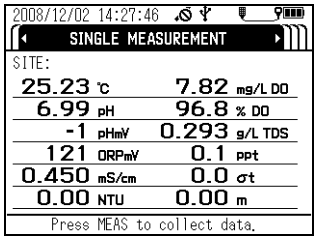


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3.5.4 Checking the calibration record

Follow the steps below to check the latest calibration history.

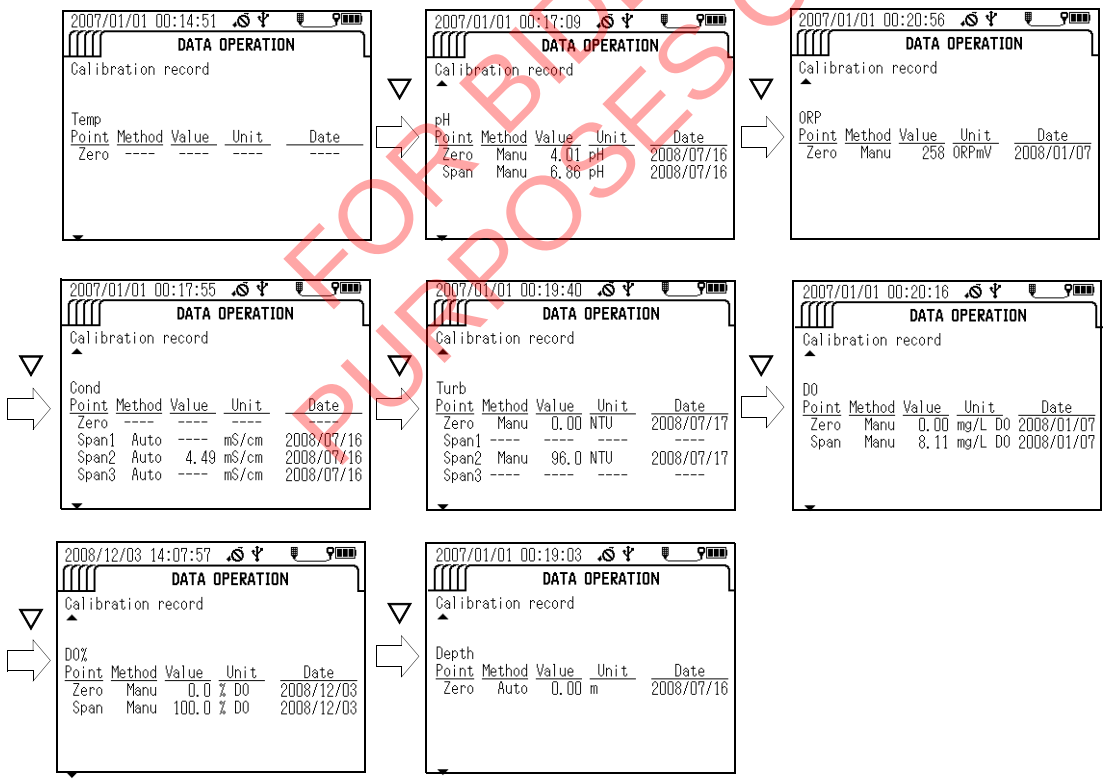
1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.



Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Press the right (▷) key 3 times to display the "DATA OPERATION" screen.**
3. **Press the down (▽) key to move the cursor to "Calibration record", then press the ENTER key.**
   The latest calibration record is displayed.



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3.5.5 GPS data operations

The menu for GPS data operations appears on the display to which the GPS unit is mounted.

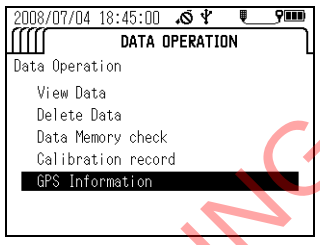
● GPS information

Follow the steps below to display acquired GPS information.

Note

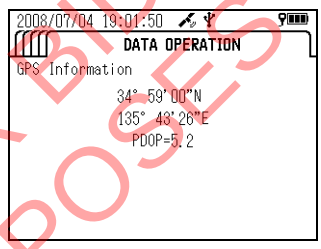
Turning the power OFF erases the GPS information.

1. **Press the right (▷) key to switch the display to the "DATA OPERATION" screen.**
2. **the down (▽) key to move the cursor to "GPS Information", then press the ENTER key.**

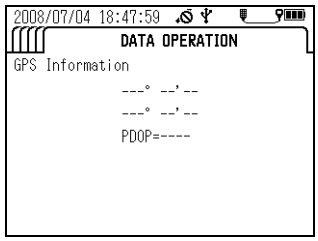


The last GPS information acquired is displayed.

● When received data exists



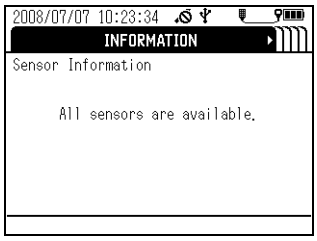
● When no received data exists



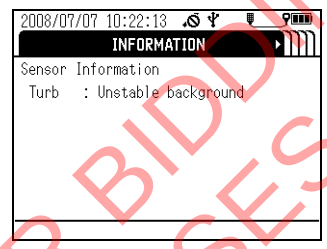
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3.6 Sensor information

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power ON.**
   The "MEASUREMENT" screen appears after about 10 seconds.
2. **Press the left (◁) key once to display the "INFORMATION" screen.**
   The "Sensor Information" screen displays the sensor probe's status.
   - When the sensor probe is normal, the display below appears.



   - When there is a sensor probe problem, individual measurement parameters generate messages such as the one shown below. Follow the troubleshooting information to remove the problem before continuing to operate the system.

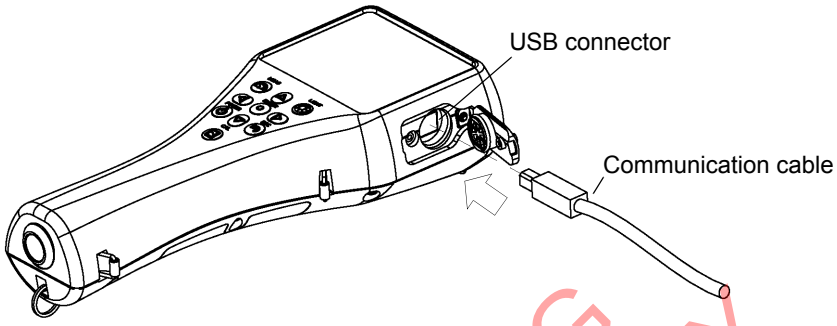


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3.7 USB communication

The separately-sold, dedicated PC connection cable comes with data collection software. This software allows data to be downloaded from the control unit in CSV format.
This section contains instructions for communication commands used for USB communication.

● Connecting the cable



Dedicated cable
Part name: Communication cable (with data collection software)
Part no.: 3200174823

● Cautions when using USB communication

Take care to observe the following when using USB communication.

- Use the dedicated cable (with data collection software) or a commercially-available USB cable (A-B type) to connect to a PC.
- Be sure to match the transmission format on the control unit and the computer.
  The control unit uses the following transmission format:

Baud rate:	19200 bps
Number of stop bits:	1 bit
Data bit length:	8 bits
Parity:	None
Flow control:	None

Tip

If the transmission formats do not match, a communication error occurs and USB communication will not function normally. After changing the transmission format, restart the control unit and the computer.

- If received data is not sent back or an error occurs after a data request has been sent, adjust the program configuration so that it allows a little waiting time before a data request is sent again. This will enable more stable communication.
- The unit does not use DCD, CTS, or DSR signals. Take care of this when creating programs.

3.7.1 Communication settings

Baud rate:	19200 bps
Number of stop bits:	1 bit
Data bit length:	8 bits
Parity:	None
Flow control:	None

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3.7.2 Commands

● Instant data requests

● Request command format

#	RD	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character	1 character
4	Frame check sequence (FCS)	2 characters

The two ASCII-code characters created by converting the 8 bits of data created by successively combining the value of each character from # through @ in an exclusive OR (XOR) operation with the value of the next character.

Example: #RD@

(1)	0	XOR	35	(ASCII code of # symbol)	⇒	35
(2)	35	XOR	82	(ASCII code of R)	⇒	113
(3)	113	XOR	68	(ASCII code of D)	⇒	53
(4)	53	XOR	64	(ASCII code of @ symbol)	⇒	117 (decimal) ↓ 75 (hex) ↓ Sets "75".

Example: 35 XOR 82 operation

35 in binary	⇒	0	0	1	0	0	0	1	1	
82 in binary	⇒	0	1	0	1	0	0	1	0	
XOR result		0	1	1	1	0	0	0	1	⇒ 113 (decimal)

Note: Set "XX" if you do not want to test for communication frame errors with FCS.

● Response format

#	RD	AAAAAAAAAAAAAAAAAAAA	X	X	XXXX	XX	X	X	XXXXX	X
1	2	3	4	5	6	7	8	9	10	11

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
12	13	14	15	16	17	18	19	20	21	22	23	24	25	26

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
27	28	29	30	31	32	33	34	35	36	37	38	39	40	41

XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
42	43	44	45	46	47	48	49	50	51	52	53	54	55	56

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XX	X	X	XXXXX	X	XX	X	X	XXXXX	X	XX	X	X	XXXXX	X
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71

XX	XX	XX	XX	XX	XX	XX	XX	XX	X	X	XXX	XX	XX	X	X	@	XX	[CR]	[LF]
72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89		

1	Header		1 character
2	Command		2 characters
3	Site name	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ( )	20 characters
4	Probe status	(3) Status code	1 character
5	Probe error	(4) Status error code	1 character
6	Unused		4 characters
7	Parameter 1 code	(1) Parameter code	2 characters
8	Parameter 1 status	(5) Parameter status code	1 character
9	Parameter 1 error	(6) Parameter error code	1 character
10	Parameter 1 data	5 characters including decimal point, right-justified with blanks filled	5 characters
11	Parameter 1 unit	(2) Unit code	1 character
12	Parameter 2 code	(1) Parameter code	2 characters
13	Parameter 2 status	(5) Parameter status code	1 character
14	Parameter 2 error	(6) Parameter error code	1 character
15	Parameter 2 data	5 characters including decimal point, right-justified with blanks filled	5 characters
16	Parameter 2 unit	(2) Unit code	1 character
17	Parameter 3 code	(1) Parameter code	2 characters
18	Parameter 3 status	(5) Parameter status code	1 character
19	Parameter 3 error	(6) Parameter error code	1 character
20	Parameter 3 data	5 characters including decimal point, right-justified with blanks filled	5 characters
21	Parameter 3 unit	(2) Unit code	1 character
22	Parameter 4 code	(1) Parameter code	2 characters
23	Parameter 4 status	(5) Parameter status code	1 character
24	Parameter 4 error	(6) Parameter error code	1 character
25	Parameter 4 data	5 characters including decimal point, right-justified with blanks filled	5 characters
26	Parameter 4 unit	(2) Unit code	1 character
27	Parameter 5 code	(1) Parameter code	2 characters
28	Parameter 5 status	(5) Parameter status code	1 character
29	Parameter 5 error	(6) Parameter error code	1 character
30	Parameter 5 data	5 characters including decimal point, right-justified with blanks filled	5 characters
31	Parameter 5 unit	(2) Unit code	1 character
32	Parameter 6 code	(1) Parameter code	2 characters
33	Parameter 6 status	(5) Parameter status code	1 character
34	Parameter 6 error	(6) Parameter error code	1 character

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35	Parameter 6 data	5 characters including decimal point, right-justified with blanks filled	5 characters
36	Parameter 6 unit	(2) Unit code	1 character
37	Parameter 7 code	(1) Parameter code	2 characters
38	Parameter 7 status	(5) Parameter status code	1 character
39	Parameter 7 error	(6) Parameter error code	1 character
40	Parameter 7 data	5 characters including decimal point, right-justified with blanks filled	5 characters
41	Parameter 7 unit	(2) Unit code	1 character
42	Parameter 8 code	(1) Parameter code	2 characters
43	Parameter 8 status	(5) Parameter status code	1 character
44	Parameter 8 error	(6) Parameter error code	1 character
45	Parameter 8 data	5 characters including decimal point, right-justified with blanks filled	5 characters
46	Parameter 8 unit	(2) Unit code	1 character
47	Parameter 9 code	(1) Parameter code	2 characters
48	Parameter 9 status	(5) Parameter status code	1 character
49	Parameter 9 error	(6) Parameter error code	1 character
50	Parameter 9 data	5 characters including decimal point, right-justified with blanks filled	5 characters
51	Parameter 9 unit	(2) Unit code	1 character
52	Parameter 10 code	(1) Parameter code	2 characters
53	Parameter 10 status	(5) Parameter status code	1 character
54	Parameter 10 error	(6) Parameter error code	1 character
55	Parameter 10 data	5 characters including decimal point, right-justified with blanks filled	5 characters
56	Parameter 10 unit	(2) Unit code	1 character
57	Parameter 11 code	(1) Parameter code	2 characters
58	Parameter 11 status	(5) Parameter status code	1 character
59	Parameter 11 error	(6) Parameter error code	1 character
60	Parameter 11 data	5 characters including decimal point, right-justified with blanks filled	5 characters
61	Parameter 11 unit	(2) Unit code	1 character
62	Parameter 12 code	(1) Parameter code	2 characters
63	Parameter 12 status	(5) Parameter status code	1 character
64	Parameter 12 error	(6) Parameter error code	1 character
65	Parameter 12 data	5 characters including decimal point, right-justified with blanks filled	5 characters
66	Parameter 12 unit	(2) Unit code (6) Parameter error code	1 character
67	Parameter 13 code	(1) Parameter code	2 characters
68	Parameter 13 status	(5) Parameter status code	1 character
69	Parameter 13 error	(6) Parameter error code	1 character
70	Parameter 13 data	5 characters including decimal point, right-justified with blanks filled	5 characters
71	Parameter 13 unit	(2) Unit code	1 character
72	Year	00 to 99	2 characters

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73	Month	01 to 12	2 characters
74	Day	01 to 31	2 characters
75	Hour	00 to 23	2 characters
76	Minute	00 to 59	2 characters
77	Second	00 to 59	2 characters
78	Longitude (degrees)	00 to 90 or "--" (no GPS data)	2 characters
79	Longitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
80	Longitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
81	Unused	1 character	1 character
82	North latitude/South latitude	N: North; S: South	1 character
83	Latitude (degrees)	000 to 180 or "---" (no GPS data)	3 characters
84	Latitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
85	Latitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
86	Unused		1 character
87	East longitude/West longitude	E: East; W: West	1 character
88	Delimiter character		1 character
89	Frame check sequence (FCS)		2 characters

● Memory data requests

● Request command format

#	RM	X	X	AAAAAAAAAAAAAAAAAAAA	XX	XX	XX	@	XX	[CR]	[LF]
1	2	3	4	5	6	7	8	9	10		

1	Header		1 character
2	Command		2 characters
3	Data specification*1	0: Start search; 1: Next data item; 2: Previous data item; 3: Request same data again	1 character
4	Search method specification	0: All data; 1: Site search; 2: Date search	1 character
5	Search site*2	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ( )	20 characters
6	Search year*3	00 to 99	2 characters
7	Search month*3	01 to 12	2 characters
8	Search day*3	01 to 31	2 characters
9	Delimiter character		1 character
10	Frame check sequence (FCS)		2 characters

*1: When sending the RM command, first send 0 [Start search], then 1 [Next data item], 2 [Previous data item] or 3 [Request same data again].

*2: [Search site] is only needed when [Site search] is specified as the search method. If another search method is specified, fill this field with spaces.

*3: [Search year], [Search month] and [Search day] are only needed when [Date search] is specified as the search method. If another search method is specified, fill this field with spaces.

FOR BIDDING PURPOSES ONLY

● **Response format**

(when data exists)

```
#   RM  AAAAAAAAAAAAAAAAAAAA  XX  X   X   XXXXX  X
1   2   3                     4   5   6   7      8

XX  X   X   XXXXX  X   XX  X   X   XXXXX  X   XX  X   X   XXXXX  X
9   10  11  12     13  14  15  16  17     18  19  20  21  22     23

XX  X   X   XXXXX  X   XX  X   X   XXXXX  X   XX  X   X   XXXXX  X
24  25  26  27     28  29  30  31  32     33  34  35  36  37     38

XX  X   X   XXXXX  X   XX  X   X   XXXXX  X   XX  X   X   XXXXX  X
39  40  41  42     43  44  45  46  47     48  49  50  51  52     53

XX  X   X   XXXXX  X   XX  X   X   XXXXX  X   XX  X   X   XXXXX  X
54  55  56  57     58  59  60  61  62     63  64  65  66  67     68

XX  XX  XX  XX  XX  XX  XX  XX  XX  X   X   XXX  XX  XX  X   X   @   XX  [CR]  [LF]
69  70  71  72  73  74  75  76  77  78  79  80   81  82  83  84  85  86
```

1	Header		1 character
2	Command		2 characters
3	Site name	Upper- and lowercase letters, numbers, periods (.) hyphens (-) and spaces ( )	20 characters
4	Parameter 1 code	(1) Parameter code	2 characters
5	Parameter 1 selection	0: No selection; 1: Selection made	1 character
6	Parameter 1 error	(6) Parameter error code	1 character
7	Parameter 1 data	5 characters including decimal point, right-justified with blanks filled	5 characters
8	Parameter 1 unit	(2) Unit code	1 character
9	Parameter 2 code	(1) Parameter code	2 characters
10	Parameter 2 selection	0: No selection; 1: Selection made	1 character
11	Parameter 2 error	(6) Parameter error code	1 character
12	Parameter 2 data	5 characters including decimal point, right-justified with blanks filled	5 characters
13	Parameter 2 unit	(2) Unit code	1 character
14	Parameter 3 code	(1) Parameter code	2 characters
15	Parameter 3 selection	0: No selection; 1: Selection made	1 character
16	Parameter 3 error	(6) Parameter error code	1 character
17	Parameter 3 data	5 characters including decimal point, right-justified with blanks filled	5 characters
18	Parameter 3 unit	(2) Unit code	1 character
19	Parameter 4 code	(1) Parameter code	2 characters
20	Parameter 4 selection	0: No selection; 1: Selection made	1 character

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21	Parameter 4 error	(6) Parameter error code	1 character
22	Parameter 4 data	5 characters including decimal point, right-justified with blanks filled	5 characters
23	Parameter 4 unit	(2) Unit code	1 character
24	Parameter 5 code	(1) Parameter code	2 characters
25	Parameter 5 selection	0: No selection; 1: Selection made	1 character
26	Parameter 5 error	(6) Parameter error code	1 character
27	Parameter 5 data	5 characters including decimal point, right-justified with blanks filled	5 characters
28	Parameter 5 unit	(2) Unit code	1 character
29	Parameter 6 code	(1) Parameter code	2 characters
30	Parameter 6 selection	0: No selection; 1: Selection made	1 character
31	Parameter 6 error	(6) Parameter error code	1 character
32	Parameter 6 data	5 characters including decimal point, right-justified with blanks filled	5 characters
33	Parameter 6 unit	(2) Unit code	1 character
34	Parameter 7 code	(1) Parameter code	2 characters
35	Parameter 7 selection	0: No selection; 1: Selection made	1 character
36	Parameter 7 error	(6) Parameter error code	1 character
37	Parameter 7 data	5 characters including decimal point, right-justified with blanks filled	5 characters
38	Parameter 7 unit	(2) Unit code	1 character
39	Parameter 8 code	(1) Parameter code	2 characters
40	Parameter 8 selection	0: No selection; 1: Selection made	1 character
41	Parameter 8 error	(6) Parameter error code	1 character
42	Parameter 8 data	5 characters including decimal point, right-justified with blanks filled	5 characters
43	Parameter 8 unit	(2) Unit code	1 character
44	Parameter 9 code	(1) Parameter code	2 characters
45	Parameter 9 selection	0: No selection; 1: Selection made	1 character
46	Parameter 9 error	(6) Parameter error code	1 character
47	Parameter 9 data	5 characters including decimal point, right-justified with blanks filled	5 characters
48	Parameter 9 unit	(2) Unit code	1 character
49	Parameter 10 code	(1) Parameter code	2 characters
50	Parameter 10 selection	0: No selection; 1: Selection made	1 character
51	Parameter 10 error	(6) Parameter error code	1 character
52	Parameter 10 data	5 characters including decimal point, right-justified with blanks filled	5 characters
53	Parameter 10 unit	(2) Unit code	1 character
54	Parameter 11 code	(1) Parameter code	2 characters
55	Parameter 11 selection	0: No selection; 1: Selection made	1 character
56	Parameter 11 error	(6) Parameter error code	1 character
57	Parameter 11 data	5 characters including decimal point, right-justified with blanks filled	5 characters
58	Parameter 11 unit	(2) Unit code	1 character
59	Parameter 12 code	(1) Parameter code	2 characters

FOR BIDDING PURPOSES ONLY

60	Parameter 12 selection	0: No selection; 1: Selection made	1 character
61	Parameter 12 error	(6) Parameter error code	1 character
62	Parameter 12 data	5 characters including decimal point, right-justified with blanks filled	5 characters
63	Parameter 12 unit	(2) Unit code	1 character
64	Parameter 13 code	(1) Parameter code	2 characters
65	Parameter 13 selection	0: No selection; 1: Selection made	1 character
66	Parameter 13 error	(6) Parameter error code	1 character
67	Parameter 13 data	5 characters including decimal point, right-justified with blanks filled	5 characters
68	Parameter 13 unit	(2) Unit code	1 character
69	Year	00 to 99	2 characters
70	Month	01 to 12	2 characters
71	Day	01 to 31	2 characters
72	Hour	00 to 23	2 characters
73	Minute	00 to 59	2 characters
74	Second	00 to 5	2 characters
75	Longitude (degrees)	00 to 90 or "--" (no GPS data)	2 characters
76	Longitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
77	Longitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
78	Unused		1 character
79	North latitude/South latitude	N: North; S: South	1 character
80	Latitude (degrees)	000 to 180 or "---" (no GPS data)	3 characters
81	Latitude (minutes)	00 to 59 or "--" (no GPS data)	2 characters
82	Latitude (seconds)	00 to 59 or "--" (no GPS data)	2 characters
83	Unused		1 character
84	East longitude/West longitude	E: East; W: West	1 character
85	Delimiter character		1 character
86	Frame check sequence (FCS)		2 characters

FOR BIDDING PURPOSES ONLY

When no data exists, or memory is at capacity)

#	RM	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character\	1 character
4	Frame check sequence (FCS)	2 characters

● Memory data count request

● Request command format

#	RN	@	XX	[CR]	[LF]
1	2	3	4		

1	Header	1 character
2	Command	2 characters
3	Delimiter character\	1 character
4	Frame check sequence (FCS)	2 characters

● Response format

#	RN	XXXXX	@	XX	[CR]	[LF]
1	2	3	4	5		

1	Header		1 character
2	Command		2 characters
3	Total data count	0 to 10000	5 characters
4	Delimiter character\		1 character
5	Frame check sequence (FCS)		2 characters

● Command parse failure response

#	??	X	XX	X	@	XX	[CR]	[LF]
1	2	3	4	5	6	7		

1	Header	1 character
2	Command	2 characters
3	Command parse failure reason*4	1 character
4	Received command*5	2 characters
5	(3) Status code for probe status*5	1 character
6	Delimiter character	1 character
7	Frame check sequence (FCS)	2 characters

*4: List of command parse failure reasons

1: Frame length error
2: FCS mismatch
3: Undefined command
4: Data error
5: Data out of range
6: No "@" delimiter character
7: No "#" header character
8: No [Carriage return] + [Line feed] footer
9: Cannot accept command in this timing.

*5: Only set for command parse failure reason 9, [Cannot accept command in this timing]. Otherwise this field is filled with spaces.

FOR BIDDING PURPOSES ONLY

4 Maintenance

Tip

HORIBA recommends regular manufacturer maintenance checks in order to ensure a long product life.

4.1 Routine care

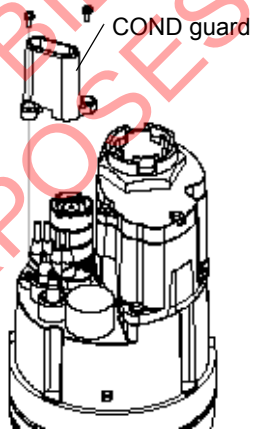
● **After measurement**

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power OFF.**

Note

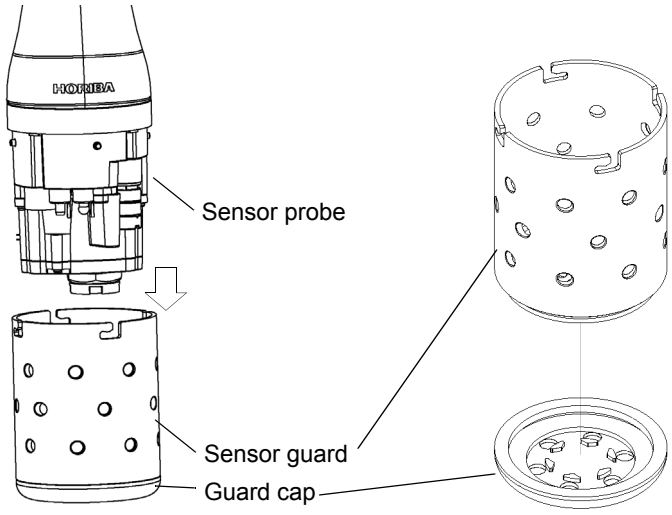
The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Remove the sensor guard, and clean the sensor with tap water.**
3. **Clean the turbidity sensor with the cleaning brush provided.**
4. **Remove the two screws securing the COND guard, and the COND guard itself, and use a test tube brush to gently remove any dirt from the electrical conductivity electrode.**



5. **Wipe off any dirt with a soft cloth. If parts are very dirty, clean them with neutral detergent, then rinse them. If parts are contaminated by oil, wipe it off with a soft cloth soaked in alcohol.**
6. **Put the COND guard back in place.**
7. **Remove the sensor guard's guard cap, wash off any dirt with tap water, then put the guard cap back in place.**

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4.2 Every 2 months maintenance

● Dissolved oxygen (DO) sensor

Note

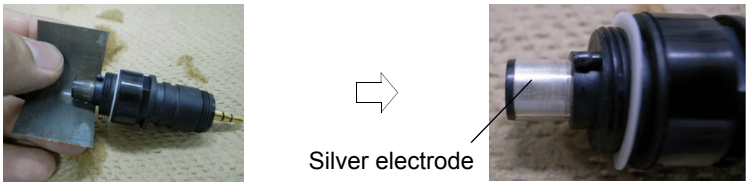
- **The DO sensor's internal solution is potassium chloride (KCl). Although KCl is harmless, protective equipment such as gloves and goggles should be worn when working with it.**
- **Internal solution can be disposed of down a sink.**

- Replace the membrane cap.
- Polish the gold and silver electrodes when replacing the membrane cap.
  The gold electrode does not need to be polished if it is not dirty.

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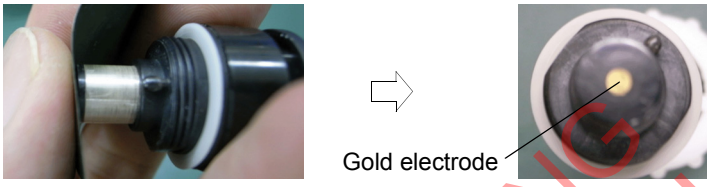
● **Silver electrode**

Polish a silver electrode part with sandpaper (#500) and then wash metal electrode parts with water.



● **Gold electrode**

Polish a gold electrode part with sandpaper (#8000) and then wash metal electrode parts with water.



Replace a membrane cap after clean metal electrodes parts.
Refer to “ 4.5 Replacing the membrane cap ” (page 87).

● **Reference electrode**

Note

- **The pH reference internal solution is potassium chloride (KCl). Although KCl is harmless, protective equipment such as gloves and goggles should be worn when working with it.**
- **Internal solution can be disposed of down a sink.**

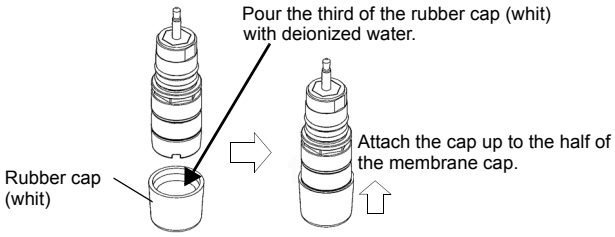
1. **Remove the rubber liquid junction plug from the reference electrode and dispose of the internal solution.**
2. **To prevent air entering, fill the reference electrode to the brim with its internal solution (No. 330).**
3. **Put the rubber liquid junction plug back in place.**
   If the rubber liquid junction plug is dirty, replace the liquid junctions (set of two; No. 9037005100). The reference electrode's internal solution will spill when replacing the liquid junctions. Rinse parts with tap water and dry them with a soft cloth.

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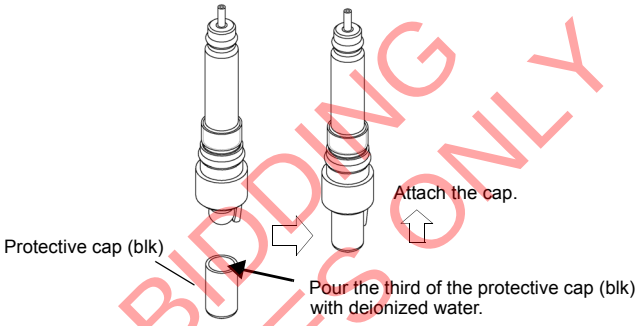
4.3 Storage

● Short-term (under 2 months) storage

- Before storing the DO sensor, pour the third of the rubber cap (whit) provided with deionized water and cover the DO sensor with them.



- Before storing the pH sensor, pour the third of the protective cap (blk) provided with deionized water and cover the pH sensor with them.



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Note

Before measuerment, remove the rubber cap (whit) and the protective cap (blk).

● Long-term (2 months or more) storage

- Remove a membrane cap from DO sensor, and wash the gold electrode and silver electrode parts with water. Wipe off the moisture before storing DO sensor in the pack.
- Prevent internal solution seeping out of the reference chip by taping over the point of seepage with electrical tape.
- Before storing the system, remove the control unit's batteries to prevent battery leakage.

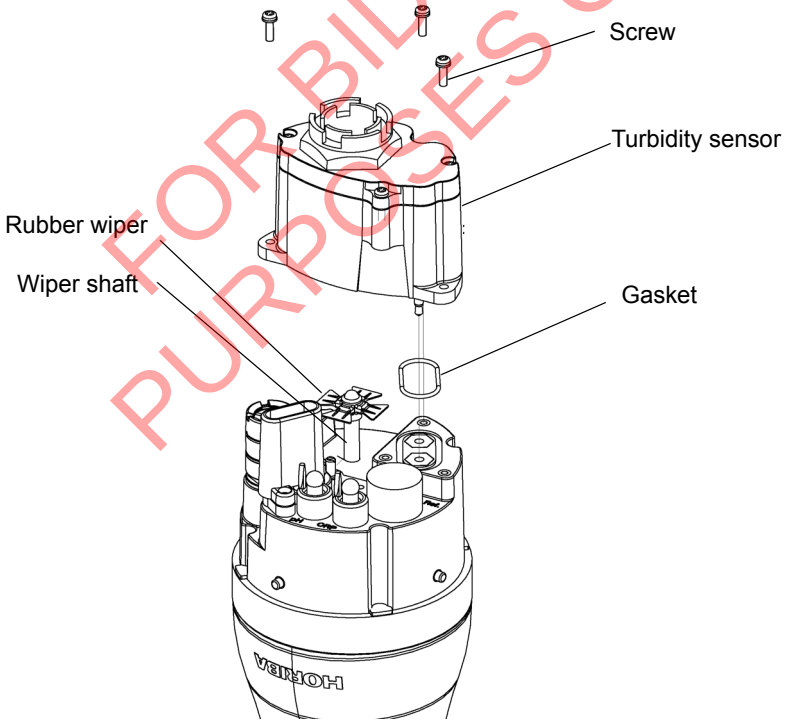
4.4 Replacing the turbidity sensor

1. **Press and hold down the control unit's POWER key for about 3 seconds to turn the power OFF.**

Note

The operation keys are designed to operate using the pad of a finger, sharp objects can tear the control unit cover damaging the operation keys.

2. **Remove the sensor guard, and clean the sensor probe with tap water.**
3. **Use dry air to blow away and dry off any moisture.**
4. **Remove the three screws holding the turbidity sensor by using No. 2 Phillips head screwdriver.**
5. **Pull out the turbidity sensor horizontally.**
6. **Remove the rubber wiper and gasket, and use a soft cloth to wipe off any dirt from the wiper shaft and turbidity sensor attachment. If parts are very dirty, use a soft cloth soaked in neutral detergent or alcohol.**
7. **Replace the rubber wiper and gasket with new ones. Coat the gasket with a thin layer of grease (No. 3014017718).**
8. **Attach the new turbidity sensor and fasten it in place with the three screws.**
9. **Perform four-point calibration before using the sensor.**



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4.5 Replacing the membrane cap

● Replacement procedure

1. **Prepare the DO sensor.**

- Take a DO sensor out of pack (newly purchasing).
- Remove a DO sensor from the sensor probe (after use).



Newly purchasing



Undo a DO sensor from the sensor probe

- Twist a membrane cap from DO sensor.
- Wash the gold electrode and silver electrode parts with water.

2. **Replace the silicone gasket with a new one.**



3. **Pour internal solution into a membrane cap with a dropper.**

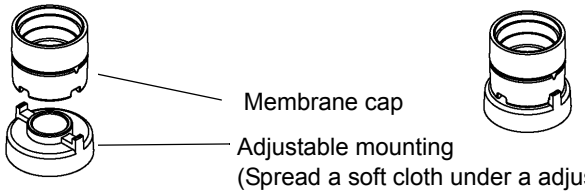


- Check air bubbles in a membrane cap.



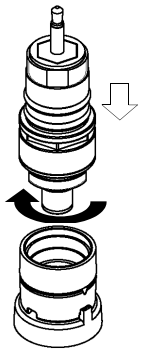
Pick a Cap up and drop it down, if there is air bubbles in internal solution of it.

4. **Set up a membrane cap on a adjustable mounting.**



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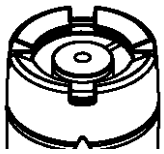
5. Attach a membrane cap to DO sensor



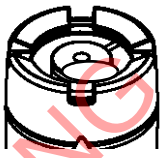
Twist a DO sensor
with holding a membrane cap tight.

6. Check for membrane surface

Check air bubbles in a membrane cap.



Good: Limited air bubbles



NG: Air bubbles of more than 5 mm in diameter

- NG → Replace a membrane cap again.
- Check that span calibration can be performed.

If the membrane cap is not attached correctly, sensitivity may be lost or response speed may decrease.

FOR BIDDING PURPOSES ONLY

4.6 Troubleshooting

Note

If the sensor probe is removed while the control unit is indicating an error, errors cannot be canceled by using the ESC key. Either reconnect the sensor probe or restart the control unit.

4.6.1 Error displays

Error	Cause	Solution
Probe ADC error	Internal IC failure	Contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error/Factory	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error/User	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.
Turbidity sensor light source error	Turbidity sensor light source failure	Turn the power OFF, wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor.
Turbidity sensor wiper motor error	The turbidity sensor wiper is not operating.	Press the ESC key. Check there are no obstacles near the wiper, then perform the measurement again. If the error persists, the motor will need to be replaced. Contact your nearest sales outlet to have the sensor probe repaired.
Probe capacitor error	Low battery voltage or internal IC failure	Turn the power OFF. Replace the display's batteries. If the error persists, contact your nearest sales outlet to have the sensor probe repaired.
Probe EEPROM error	Internal IC failure	Press the ESC key, then redo the operation. If the error persists, turn the power OFF, then restart the system (the current data will not be saved). If the error still persists, contact your nearest sales outlet to have the display repaired.
Probe board error	Probe board failure	Turn the power OFF. Contact your nearest sales outlet to have the sensor probe repaired.

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Error	Cause	Solution
Zero-point calibration error	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. There is moisture on the sensor. 2. The sensor is dirty. 3. The COND sensor is broken.	COND sensor 1. Blow-dry the moisture off the sensor. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. There are air bubbles in the internal solution. 2. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the DO sensor.
	Water depth sensor 1. The water depth sensor is dirty. 2. The water depth sensor has failed.	Water depth sensor 1. Clean the water depth sensor. 2. Contact your nearest sales outlet.

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Error	Cause	Solution
Span calibration error	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	ORP sensor 1. The ORP standard solution is contaminated. 2. The ORP electrode is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The ORP electrode has failed.	ORP sensor 1. Replace the standard solution with new solution. 2. Clean the ORP electrode. 3. Refil the reference electrode's internal solution. 4. Replace the ORP electrode.
	COND sensor 1. The calibration solution is not correct. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Use the correct calibration solution for calibration. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. The diaphragm is torn. 2. There are air bubbles in the internal solution. 3. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 3. Replace the DO sensor.
	Temperature sensor The temperature sensor has failed.	Temperature sensor Contact your nearest sales outlet.
Calibration stability error	The calibration value of an individual parameter is not stable. 1. The sensor is dirty. 2. The sensor has not adjusted to the standard solution. 3. The temperature was unstable during calibration.	1. Clean the sensor. 2. Fill the transparent calibration cup with pH 4 standard solution, and wait for at least 20 minutes of conditioning before starting calibration. 3. Start calibration after the temperature has stabilized.
Turbidity calibration error	Error in turbidity measurement sequence	Turbidity calibration failed. Redo calibration after removing the displayed error.
Wet check	The cable connector is submerged.	Turn the power OFF and disconnect the cable connector. Wipe or blow-dry off all the water droplets on the probe. If the error persists, contact your nearest sales outlet to have the display and sensor probe repaired.
Power voltage error	The display's power board has failed.	This error could also be caused by poor cable contact. Turn the power OFF and disconnect the cable connector. Reconnect the connector and turn the power ON. If the error persists, contact your nearest sales outlet to have the display and sensor probe repaired.
Turbidity lamp power voltage error	The remaining battery level is low.	Turn the power OFF and replace the display's batteries with new ones.

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Error	Cause	Solution
Display RTC error	The time display is incorrect.	Replace the coin battery.
Display FROM error	Internal IC failure	Contact your nearest sales outlet to have the control unit repaired.
Display EEPROM error	Internal IC failure	Contact your nearest sales outlet to have the control unit repaired.
Display save error	Insufficient memory space	Move data from the display, use the data operations screen to delete data, then redo the measurement.
Measurement sequence error	● When the measurement item is turbidity 1. The battery power is low. 2. The wiper is not operating normally. 3. The light source lamp is not lit. ● If items other than turbidity are also displayed 4. Board failure	1. Replace the batteries with new ones. 2. Check there are no obstacles near the wiper, then redo the measurement. If the error persists, the motor will need to be replaced. Contact your nearest sales outlet to have the sensor probe repaired. 3. Wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor. 4. Contact your nearest sales outlet to have the sensor probe repaired.
Out of measurement range	The attempted measurement is outside the measurement range supported for that item.	The system must be used within its supported measurement ranges.
Last zero-point calibration invalid	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. There is moisture on the sensor. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Blow-dry the moisture off the sensor. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. There are air bubbles in the internal solution. 2. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the DO sensor.
	Water depth sensor 1. The water depth sensor is dirty. 2. The water depth sensor has failed.	Water depth sensor 1. Clean the water depth sensor. 2. Contact your nearest sales outlet.
Out of measurement range	[See above.]	[See above.]
Last zero-point calibration invalid		

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Error	Cause	Solution
Last span calibration invalid	pH sensor 1. The pH standard solution is contaminated. 2. The pH-responsive membrane is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The pH-responsive membrane is torn.	pH sensor 1. Replace the standard solution with new solution. 2. Clean the pH-responsive membrane. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	ORP sensor 1. The ORP standard solution is contaminated. 2. The ORP electrode is dirty. 3. The concentration of the reference electrode's internal solution has changed. 4. The ORP sensor glass is broken.	ORP sensor 1. Replace the standard solution with new solution. 2. Clean the ORP electrode. 3. Refil the reference electrode's internal solution. 4. Replace the sensor.
	COND sensor 1. The calibration solution is not correct. 2. The sensor is dirty. 3. The COND sensor has failed.	COND sensor 1. Use the correct calibration solution for calibration. 2. Clean the sensor. 3. Contact your nearest sales outlet.
	TURB sensor 1. There are air bubbles on the cell. 2. The cell window is dirty. 3. The sensor is being affected by ambient light. 4. The solution is dirty. 5. The TURB sensor has failed.	TURB sensor 1. Shake the sensor probe vigorously. 2. Clean the cell window. 3. Calibrate using the calibration cup provided. 4. Replace the solution with new solution. 5. Replace the TURB sensor.
	DO sensor 1. The diaphragm is torn. 2. There are air bubbles in the internal solution. 3. The DO sensor has failed.	DO sensor 1. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 2. Replace the diaphragm with a new one, and fill the DO sensor with new internal solution. 3. Replace the DO sensor.
	Temperature sensor ● The temperature sensor has failed.	Temperature sensor ● Contact your nearest sales outlet.
Out of measurement range Last zero-point calibration invalid	[See above.]	[See above.]
Last span calibration invalid	The calibration value of an individual parameter is not stable. 1. The sensor is dirty. 2. The sensor has not adjusted to the standard solution. 3. The temperature was unstable during calibration.	1. Clean the sensors. 2. Fill the transparent calibration cup with pH 4 standard solution, and wait for at least 20 minutes of conditioning before starting calibration. 3. Start calibration after the temperature has stabilized.
Out of measurement range Last zero-point calibration invalid	[See above.]	[See above.]
Calibration value is factory default value.	Internal IC failure	Turn the power OFF, then restart the system. If the error persists, initialize the system from the "System" menu. If the error still persists, contact your nearest sales outlet to have the sensor probe repaired.

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Error	Cause	Solution
Sample is unstable.	1. The concentration of the sample is unstable. 2. External light disturbance has affected the sensor. 3. Water has entered the turbidity sensor's connector.	1. Use a stirrer to agitate the sample during measurement. 2. Perform measurement away from direct sunlight. 3. Turn the power OFF, wipe off any water droplets on the probe, then remove the turbidity sensor. Check there are no water droplets around the turbidity sensor connector, then mount the sensor again. If the error persists, replace the turbidity sensor.

4.6.2 Error displays in sensor information

Error display	Cause	Solution
Measurement sequence error	Measurement sequence error	Turn the power OFF, then restart the system. If the error persists, have the probe repaired.
Out of measurement range	The measurement value is outside the measurement range.	Samples for measurement must be within the measurement range.
Last calibration invalid	The last calibration failed.	Redo calibration.
Calibration invalid	The calibration value is the factory default value.	Redo calibration.
Background unstable	The U-53 turbidity sensor is exposed to direct light.	Mount the guard cap and sensor guard and perform measurement away from direct sunlight.
	The turbidity value changed rapidly during measurement.	Measure a sample that has stable turbidity.

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5 Specifications

Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
Sensor probe	Measurement temperature range	−10°C to 55°C	✓	✓	✓	✓	✓
	Maximum sensor outer diameter	Approx. 96 mm					
	Sensor length	Approx. 340 mm					
	Cable length	2 m (standard) 10 m/30 m (options)					
	Mass	Approx. 1800 g					
	Auto calibration function	Uses pH 4 standard solution.					
	Measurement depth	30 m max.	✓	✓	✓	✓	✓
	Wet-part materials*3	PPS, glass, SUS316L, SUS304, FKM, PEEK, Q, titanium, FEP membrane, POM					
	Waterproofing standard	IP-68					
Control unit	Outer dimensions (W × D × H)	115 × 66 × 283 mm	✓	✓	–	✓	–
		115 × 66 × 335 mm	–	–	✓	–	✓
	Mass	Approx. 800 g	✓	✓	✓	✓	✓
	LCD	320 × 240 mm graphic LCD (monochrome) with backlight	✓	✓	✓	✓	✓
	Memory data items	10000	✓	✓	✓	✓	✓
	Communication interface	USB peripheral	✓	✓	✓	✓	✓
	Batteries	C-size dry cells (×4)	✓	✓	✓	✓	✓
	Waterproofing standard	IP-67	✓	✓	✓	✓	✓
	GPS unit	● Reception method (12 channel parallel) ● Measurement precision [With PDOP (high precision): 30 m or less (2 drms)]	–	–	✓	–	✓
	Estimated battery life*1	–	70 hours (no backlight)			500 measurements (no backlight)	
	Storage temperature range	−10°C to 60°C	✓	✓	✓	✓	✓
	Ambient temperature range	−5°C to 45°C					

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Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
pH measurement Two calibration	Measurement method	Glass electrode method	✓	✓	✓	✓	✓
	Range	pH 0 to 14					
	Resolution	0.01 pH					
	Precision*2	±0.1 pH					
Dissolved oxygen measurement ● Salinity conversion (0 to 70 PPT, automatic) ● Automatic temperature compensation	Measurement method	Polarographic method	✓	✓	✓	✓	✓
	Film thickness	25 μm					
	Range	0 mg/L to 50.0 mg/L					
	Resolution	0.01 mg/L					
	Precision*2	0 mg/L to 20 mg/L: ±0.2 mg/L 20 mg/L to 50 mg/L: ±0.5 mg/L					
Electrical conductivity measurement ● Auto range ● Automatic temperature conversion (25°C)	Measurement method	Four-AC-electrode method	✓	✓	✓	✓	✓
	Range	0 S/m to 10 S/m (0 mS/cm to 100 mS/cm)					
	Resolution	0.000 mS/cm to 0.999 mS/cm: 0.001 1.00 mS/cm to 9.99 mS/cm: 0.01 10.0 mS/cm to 99.9 mS/cm: 0.1 0.0 mS/m to 99.9 mS/m: 0.1 0.100 S/m to 0.999 S/m: 0.001 1.00 S/m to 9.99 S/m: 0.01					
	Precision*2	1% of full-scale (midpoint of two calibration points)					
Salinity measurement	Measurement method	Electrical conductivity conversion	✓	✓	✓	✓	✓
	Range	0 PPT to 70 PPT (parts per thousand)					
	Resolution	0.1 PPT					
	Precision	±3 PPT					
TDS (total dissolved solid) measurement ● Conversion coefficient setting	Measurement method	Electrical conductivity conversion	✓	✓	✓	✓	✓
	Range	0 g/L to 100 g/L					
	Resolution	0.1% of full-scale					
	Repeatability	±2 g/L					
	Precision	±5 g/L					
Seawater specific gravity measurement ● σt, σ0, σ15 display	Measurement method	Electrical conductivity conversion	✓	✓	✓	✓	✓
	Range	0 σt to 50 σt					
	Resolution	0.1 σt					
	Precision	±5 σt					

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Specification		Basic value	Model				
			U-51	U-52	U-52G	U-53	U-53G
Temperature measurement	Measurement method	Platinum temperature sensor	✓	✓	✓	✓	✓
	Range	−10°C to 55°C					
	Resolution	0.01°C					
	Sensor	Platinum temperature sensor, JIS Class B (0.3 + 0.005 |t|)					
Turbidity measurement	Measurement method		–	LED forward 30° transmission/ scattering method		Tungsten lamp 90° transmission scattering method	
	Range			0 NTU to 800 NTU		0 NTU to 1000 NTU	
	Resolution			0.1 NTU		0.01 NTU	
	Precision*2			±5%of readout or ±1 NTU, whichever is larger		● ±0.5NTU (for 0 NTU to 10 NTU measurement range) ● 3% of readout or 1 NTU, whichever is larger (for 10 NTU to 1000 NTU measurement range)	
	Turbidity sensor wiper			–		✓	
Water depth measurement	Measurement method	Pressure method	–	–	✓	✓	✓
	Range	0 m to 30 m					
	Resolution	0.05 m					
	Precision*2	±0.3 m					
ORP (oxidation reduction potential) measurement	Measurement method	Platinum electrode method	✓	✓	✓	✓	✓
	Range	−2000 ～ +2000 mV					
	Resolution	1 mV					
	Precision*2	±15 mV					

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*1: Battery life is estimated under following conditions.
- Continuous operation
- Using batteries: C-size alkaline dry cells
- Ambient temperature of the control unit: 20°C or more
- Backlight off

*2: The precision is defined by measuring the standard solution in the following cases.
- Turbidity and conductivity: after four point calibration
- pH and DO: after two point calibration
- Water depth and ORP: after one point calibration

*3: Metallic parts are made of stainless steel. Immersing in seawater may erode metallic parts.

6 Reference

6.1 Consumable parts

● Sensor

Name	Model	No.	Description
pH sensor	#7112	3014057312	Standard type pH sensor
pH sensor ToupH	#7113	3200170923	Tough glass type pH sensor
ORP sensor	#7313	3200170920	
DO sensor	#7543	3200170924	
Reference electrode	#7210	3200043582	
R bush unit	—	3200043587	Reference electrode liquid junction
TURB cell U-52	#7800	3200172803	For U-52/U-52G
TURB cell U-53	#7801	3200172800	For U-53/U-53G
Membrane cap	—	3200170194	For DO sensor

● Standard solution and inner solution

Name	Model	No.	Description
pH 4 (For automatic calibration) 500 mL	#100-4	3200043638	Standard solution for auto calibration. Also used for manual pH span calibration.
pH 4 (For automatic calibration) 4 L	#140-4	3200174430	
pH 7 500 mL	#100-7	3200043637	Standard solution for pH zero-point calibration.
pH 9 500 mL	#100-9	3200043636	Standard solution for pH manual span calibration.
Powder for ORP standard solution 10 packs	#160-51	3200043618	For ORP calibration.
Powder for ORP standard solution 10 packs	#160-22	3200043617	
Inner solution for DO sensor, 50 mL	#306	3200170938	Internal solution for DO sensor.
Internal solution for pH, 250 mL	#330	3200043641	Supplementary internal solution for pH reference electrode.

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● Others

Name	Model	No.	Description
Silicone grease	—	3014017718	Silicone grease for coating sensor O-ring.
Sponge brush unit	—	3200169531	Brush for cleaning sensor probe.
O-ring set for reference electrode	—	3200169376	O-rings for reference electrode.
O-ring set for DO sensor	—	3200169426	O-rings for DO sensor.
Rubber cap set for sensor guard	—	3200169428	Rubber caps used between sensor guard and sensor probe.
O-ring set for pH and ORP sensor	—	3200169520	O-rings for pH and ORP sensors.
Wiper unit	—	3200169789	Rubber wiper for U-53/U-53G turbidity sensors.
Protective cap (blk) for pH sensor	—	3200175019	Cap attached to tip of pH sensor for sensor probe storage.
Rubber cap (whit) for DO sensor	—	3200175020	Cap attached to tip of DO sensor for sensor probe storage.

6.2 Options sold separately

Name	Model	No.	Description
Bag	U-5030	3200174772	Storage bag for sensor probes and flow cell. Can be carried in one hand.
Flow cell assy	—	3200156570	Used when collecting measurement samples by pump.
Probe guard	—	3200167002	Used for taking measurements in locations where there is a current or where there is a thick layer of sludge.
Communication cable	—	3200174823	A PC connection cable. Comes with data collection software.

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6.3 pH measurement

6.3.1 Principle of pH measurement

U-50 series use the glass electrode method for pH measurements. The glass electrode method measures a potential difference between the glass film for pH and the reference electrode. For more information, refer to “JIS Z 8802 pH measurement method”.

6.3.2 Temperature compensation

The electromotive force generated by the glass electrode changes depending on the temperature of the solution.

Temperature compensation is used to compensate for the change in electromotive force caused by temperature.

This function does not compensate the change in pH caused by the temperature of the solution. When pH is to be measured, the temperature of the solution must be recorded along with that pH value, even if a pH meter has automatic temperature compensation function. If the solution temperature is not recorded, the results of the pH measurement may be meaningless.

6.3.3 Standard solutions

When measuring pH, the pH meter must be calibrated using standard solution. There are five kinds of standard solutions specified in “JIS Z 8802 pH measurement”. For normal measurement, two of standard solutions with pH of 4, 7, and 9 are sufficient to accurately calibrate the meter.

For standard solutions, refer to “JIS Z 8802 pH measurement”.

pH 4 standard solution: (Phthalate) 0.05 mol/L potassium hydrogen phthalate aqueous solution

pH 7 standard solutio: (Neutral phosphate) 0.025 mol/L potassium dihydrogenphosphate, 0.025 mol/L disodium hydrogenphosphate aqueous solution

pH 9 standard solution: (Borate) 0.01 mol/L sodium tetraborate aqueous solution

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Table 2 pH values of pH standard solutions at various temperatures settings

Temp. (℃)	pH 4 standard solution Phthalate	pH 7 standard solution Neutral phosphate	pH 9 standard solution Borate
0	4.01	6.98	9.46
5	4.01	6.95	9.39
10	4.00	6.92	9.33
15	4.00	6.90	9.27
20	4.00	6.88	9.22
25	4.01	6.86	9.18
30	4.01	6.85	9.14
35	4.02	6.84	9.10
40	4.03	6.84	9.07
45	4.04	6.84	9.04

6.4 DO measurement

6.4.1 Principle of DO measurement

Dissolved oxygen (DO) refers to the amount of oxygen that is contained in water.

The concentration of dissolved oxygen is generally given as mg/L or as a percentage value (the dissolved oxygen saturation ratio).

Dissolved oxygen is essential for maintaining the self-purifying ability of rivers and seas and also for fish to live. The concentration of dissolved oxygen acts as an indicator of water quality. It is often measured when processing waste water and managing water quality. Fig. 1 provides an overview of the principles behind dissolved oxygen sensor measurement.

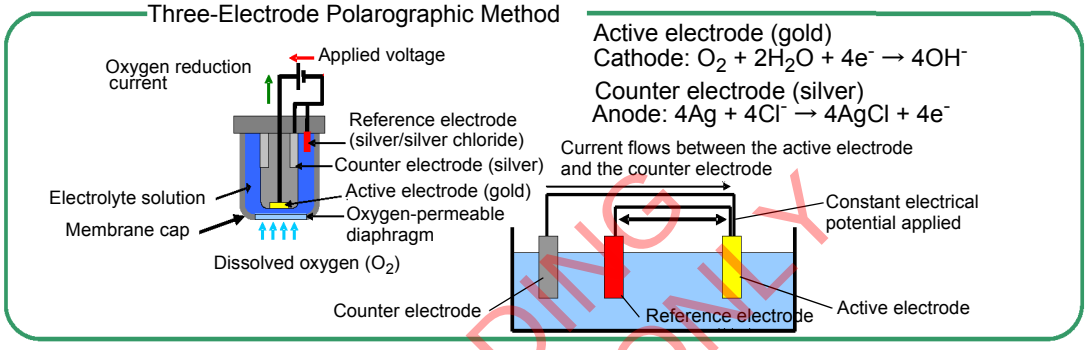


Fig. 1 Overview of principles behind dissolved oxygen sensor

The polarographic oxygen sensor is an enclosed sensor wherein voltage is applied to a cathode made of a precious metal (such as gold or platinum) and an anode also made of a precious metal (such as silver) via an external circuit, and a cap with an oxygen permeable diaphragm (membrane) is filled with electrolyte solution. As indicated in Fig. 1, the concentration of dissolved oxygen can be measured by measuring the current proportional to the amount of reduced oxygen when oxygen that has dispersed through the oxygen permeable diaphragm produces a reductive reaction on the surface of the active electrode (gold). The method of measuring dissolved oxygen based on the above principle is called the Membrane Electrode Method. Compared to the Chemical Analysis Method, which requires complicated pre-processing to alleviate the effect of reduced materials and oxidizing materials, this method allows dissolved oxygen to be measured very easily. It is also easy to remove undesired buildup from the silver electrode by polishing and cleaning if an insulator forms on it due to oxidation, making the method reusable.

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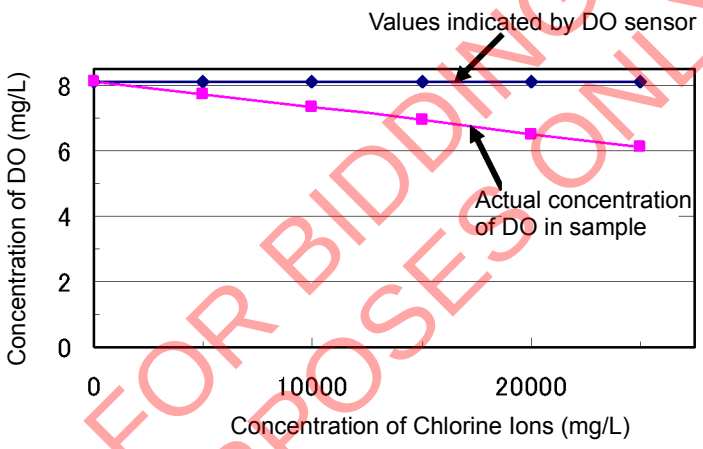
6.4.2 Salinity calibration

When the solution and air come into contact and form an equilibrium (i.e. saturation), the relationship between the concentration of dissolved oxygen in the solution, C, [mol/L], and the partial pressure of oxygen in the air, Ps, [MPa/(mg/L)], can be represented by the following formula:

$$C = Ps/H$$

Where H [MPa/(mg/L)] is the Henry constant, a value that changes according to the composition of the solution. As H typically becomes larger as the salinity of the water increases, C becomes smaller.

The DO sensor detects the partial pressure of oxygen (Ps) in the above formula. Accordingly, if the DO sensor is immersed in deionized water saturated with air, or in an aqueous solution containing salt, the output current does not change, resulting in an erroneous measurement. For example, when salt is added to a sample, the amount of oxygen that can be dissolved in the solution decreases, but because the partial pressure of oxygen does not change, the value displayed by the control unit stays the same regardless of salt content. This concept is indicated in graph form below. (Fig. 2)



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Fig. 2 Relationship between chlorine ion concentration and dissolved oxygen concentration

In samples with a high salt concentration, the solubility of oxygen is lower, but as the partial pressure of oxygen does not change, the value actually indicated on the control unit is higher than the actual value. In order to obtain a measurement of the concentration of dissolved oxygen in an aqueous solution that contains salt, it is therefore necessary to first perform salinity compensation. Conventionally, dissolved oxygen sensors have performed salinity compensation by inputting the salinity of the sample. This is fine as long as the salinity is already known. However, in most cases salinity is unknown, so even if dissolved oxygen sensors contained a salinity compensation function, it was of no practical use.

The U-50 Series can calculate and measure salinity in samples from electrical conductivity values, and can thus be used to automatically compensate for salinity.

6.5 Conductivity (COND) measurement

6.5.1 Four-AC-electrode method

Conductivity is an index of the flow of electrical current in a substance.

Salts dissolved in water are separated into cations and anions. Such solution is called electrolytic solution.

Electrolytic solution has the property of allowing the flow of current according to Ohm's law. This property is referred

to as ionic conductivity, since current flow is caused by ion movement in electrolytic solution.

Metals, on the other hand, allow the flow of current by means of electrons. This property is called electronic conductivity,

which is distinguished from ionic conductivity.

A cube with 1 m on each side, as shown in Fig. 3, is used to demonstrate an electrolytic solution. Two electrode plates are placed on opposite sides, and the cube is filled with solution. If the resistance between these two electrode plates is represented by r(Ω), the conductivity of the solution L($S \cdot m^{-1}$) is represented as L=1/r. S stands for Siemens, a unit of measurement of conductance.

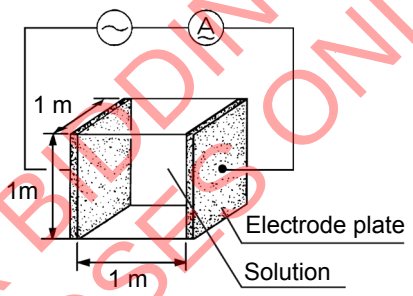


Fig. 3 Definition of conductivity

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The most general method for measuring conductivity is based on the above principle, and is called the 2-electrode method.

In the 2-electrode method the influence of polarization cannot be ignored for solutions with high conductivity and conductivity cannot be measure accurately. In addition, contamination on the surface of the electrode increases apparent resistance, resulting in inaccurate measurement of conductivity.

The U-50 series has adopted the 4-electrode method to overcome these disadvantages of the the 2-electrode method.

As shown in Fig. 4, the U-50 series uses two voltage-detecting electrodes and two voltage-applying electrodes, for a total of four electrodes. The voltage-detecting electrodes are for detecting AC voltage, and the voltage-applying electrodes are for applying AC voltage.

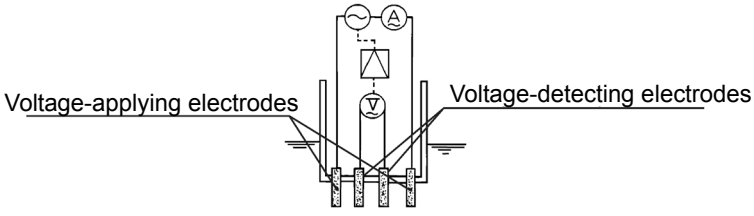


Fig. 4 Principle of the 4-electrode method

Let us assume that the current, I(A), flows in a sample of conductivity L – under automatic control of the voltage-applying electrodes – so that the voltage at the voltage-detecting-electrodes, E(V), remains constant at all times.
Then, the resistance of the sample, R(Ω), across the voltage-detecting electrodes is represented as R=E/I. The resistance, R, of the sample is inversely proportional to its conductivity, L. Accordingly, a measurement of current, Is,
of a standard solution of known conductivity, Ls, enables calculation of conductivity of a sample according to the formula L = Ls (I/Is) from the ratio L : Ls = I : Is.
Even in the 4-electrode method, polarization occurs, since AC current flows in the voltage-applying electrodes. The voltage-detecting electrodes are, however, free from the effects of polarization, since they are separated from the voltage-applying electrodes, and furthermore, current flow is negligible. Therefore, the 4-electrode method is an excellent method to enable measurement of conductivity covering a very high range.

6.5.2 SI units

New measurement units, called SI units, have been in use from 1996. Accordingly, the U-50 series also uses SI units. The following conversion table is provided for people who use the conventional kind of conductivity meter.
Note that along with the change in unit systems, the measurement values and cell counts have also changed.

	Former units	→	SI unit
Measurement value	0.1 mS/cm	→	0.01 S/m
	1 mS/cm	→	0.1 S/m
	100 mS/cm	→	10 S/m

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6.5.3 Temperature coefficient

In general, the conductivity of a solution varies largely with its temperature.
The conductivity of a solution depends on the ionic conductivity, described earlier. As the temperature rises, conductivity becomes higher since the movement of the ions becomes more active.
The temperature coefficient shows the change in % of conductivity per °C, with a certain temperature taken as the reference temperature. This is expressed in units of %/°C. The temperature coefficient assumes the premise that the conductivity of a sample changes linearly according to temperature.
Strictly speaking, with actual samples, however, conductivity changes along a curve. Furthermore, the cuve varies with the type of sample. In the ranges of smaller temperature changes, however, samples are said to have the temperature coefficient of 2%/°C (at reference temperature 25°C); this holds for most samples, except in certain special cases.
(The temperature coefficients for various types of solutions are listed on the next page.)
The U-50 series uses an automatic temperature conversion function to calculate conductivity at 25°C at a temperature
coefficient of 2 %/°C based on the measured value of the temperature. Results are displayed on the readout.
The U-50 series's temperature conversion function is based on the following formula.

$L_{25} = L_t / \{ 1 + K (t - 25) \}$

L_{25} : Conductivity of solution converted to 25°C
t : Temperature of solution at time of measurement (°C)
L_t : Conductivity of solution at t (°C)
K : Temperature coefficient (%/°C)

● Conductivity and temperature coefficient for various solutions

Conductivity and related temperature coefficients of representative substances (at 25°C) are shown in the table below.

Substance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp.coef. (%/°C)	Substance	Temp. (ºC)	Conc. (wt%)	Cond. (S/m)	Temp.coef. (%/°C)
NaOH	15	5	19.69	2.01	NaCl	18	5	6.72	2.17
		10	31.24	2.17			10	12.11	2.14
		15	34.63	2.49			15	16.42	2.12
		20	32.70	2.99			20	19.57	2.16
		30	20.22	4.50			25	21.35	2.27
		40	11.64	6.48	Na_2SO_4	18	5	4.09	2.36
KOH	15	25.2	54.03	2.09			10	6.87	2.49
		29.4	54.34	2.21			15	8.86	2.56
		33.6	52.21	2.36	Na_2CO_3	18	5	4.56	2.52
		42	42.12	2.83			10	7.05	2.71
NH_3	15	0.1	0.0251	2.46			15	8.36	2.94
		1.6	0.0867	2.38	KCl	18	5	6.90	2.01
		4.01	0.1095	2.50			10	13.59	1.88
		8.03	0.1038	2.62			15	20.20	1.79
		16.15	0.0632	3.01			20	26.77	1.68
HF	18	1.5	1.98	7.20			21	28.10	1.66
		4.8	5.93	6.66	KBr	15	5	4.65	2.06
		24.5	28.32	5.83			10	9.28	1.94
HCl	18	5	39.48	1.58			20	19.07	1.77
		10	63.02	1.56	KCN	15	3.25	5.07	2.07
		20	76.15	1.54			6.5	10.26	1.93
		30	66.20	1.52			—	—	—
H_2S0_4	18	5	20.85	1.21	NH_4Cl	18	5	9.18	1.98
		10	39.15	1.28			10	17.76	1.86
		20	65.27	1.45			15	25.86	1.71
		40	68.00	1.78			20	33.65	1.61
		50	54.05	1.93			25	40.25	1.54
		60	37.26	2.13	NH_4NO_3	15	5	5.90	2.03
		80	11.05	3.49			10	11.17	1.94
		100.14	1.87	0.30			30	28.41	1.68
		—	—	—			50	36.22	1.56
HNO_3	18	6.2	31.23	1.47	$CuSO_4$	18	2.5	10.90	2.13
		12.4	54.18	1.42			5	18.90	2.16
		31	78.19	1.39			10	32.00	2.18
		49.6	63.41	1.57			15	42.10	2.31
		62	49.64	1.57	CH_3COOH	18	10	15.26	1.69
H_3PO_4	15	10	5.66	1.04			15	16.19	1.74
		20	11.29	1.14			20	16.05	1.79
		40	20.70	1.50			30	14.01	1.86
		45	20.87	1.61			40	10.81	1.96
		50	20.73	1.74			60	4.56	2.06

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6.6 Salinity (SAL) conversion

The U-50 series is designed to calculate salinity as well as the other parameters.
Note that the “salinity” here is the salinity of sea water. There is a constant relation between conductivity and salinity at certain temperatures.
Therefore, if data on the conductivity and temperature are available, the corresponding salinity can be known. In other words, the salinity measurement of the U-50 series is based on the principle of calculating the salt content, making use of the measured values of conductivity and temperature.
Note therefore, that measured results of all substances whose conductivity is detected are displayed as salinity. For example, the measured result is displayed as NaCl concentration, even if in fact the sample component is, hydrochloric acid (HCl).

6.7 TDS conversion

TDS is short for Total Dissolved Solids and means the total dissolved solid amount.
The conductivity of a solution is affected by the amount of salinity, minerals, and dissolved gases. That is, conductivity is an index that shows the total amount of all substances in the solution. Of these substances, TDS indicates only the amount of dissolved solids.
TDS can be used for a comparison of the state of substances composed of a single component such as NaCl. However, the use of TDS for the comparison of solutions of different types causes serious errors.
Conductivity and TDS are expressed by the following formulas.
Conductivity in SI units (S/m) ..... TDS(g/L) = L (S/m) × K × 10
TDS(g/L) = L (mS/m) × K ÷ 100
Conductivity in the old units (mS/cm) ..... TDS(g/L) = L (mS/cm)× K
K = TDS coefficient
Initial settings use the values listed in the table (Page 80) that generally uses TDS coefficients.
For accurate TDS comparisons, find the TDS coefficient from measured conductivity values. Then set the value thus obtained and make measurements.

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6.8 σt conversion

- **Specific gravity of seawater**

The density and specific gravity of seawater are equal numerically and generally are not distinguished strictly. Since seawater density ρ is between 1.000 and 1.031, 1 is subtracted from ρ and σ is obtained by multiplying the value by 1000.
The resultant value is used as the specific gravity of seawater.
$\sigma = (\rho - 1) \times 1000$
The density of seawater ρ is expressed by function of temperature, hydraulic pressure, and salinity. The density of seawater under the atmospheric pressure is expressed as σ_t. The density of seawater under the atmospheric pressure is determined by temperature and salinity.
The U-50 Series models make salinity measurement through temperature measurements and conductivity conversion and find σ_t through calculations.
In Japan σ_{15} at 15°C is called a standard specific gravity and widely used while in foreign countries σ_0 at 0°C is employed. σ_{15} and σ_0 are determined by the function of salinity.
In ocean surveys, in particular, these values σ_t, σ_{15}, and σ_0 are more widely used than conductivity and salinity and, in the U-50 Series models, newly added as measurement components.

6.9 Turbidity (TURB) measurement

6.9.1 Principle of turbidity measurement

U-52 and U-53 sensors measure turbidity using the Transmitting and Scattering Method shown in Fig. 5. U-52 sensors use a pulse light LED (infra-red emitting diode) as a light source, and detect scattered light from a 30° angle off center. U-53 sensors use a tungsten lamp as a light source and detect scattered light from a 90° angle. Both models display turbidity as a ratio of scattered light to transmitted light to reduce the affect of the color of the sample. The U-53 method conforms to EPA Method 180.1, and employs wipers to reduce the affect of air bubbles.

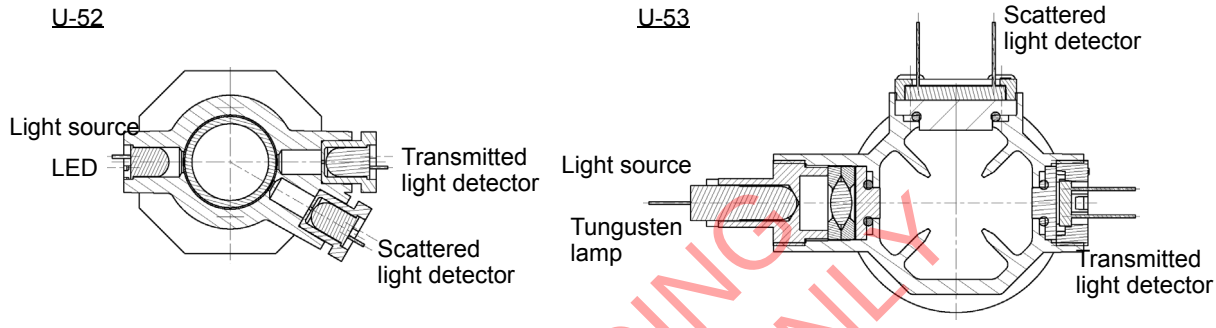


Fig. 5 Turbidity cell

6.9.2 Standard solution

U-50 series can perform calibration using formazin (NTU) or kaolin standard solutions as a turbidity standard solution. However, units for the solution used for calibration should be displayed in measurements. Do not use more than 400 mg/L of kaolin standard solution because it increases precipitation speed, resulting in measurement error.

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6.10 Depth (DEPTH) measurement

6.10.1 Principle of depth measurement

For the W-22XD and W-23XD models, depth measurement can be made through use of a pressure gauge. The principle of the depth measurement uses the relation between depth and pressure.

Although the measurement with the depth sensor is affected by atmospheric pressure, the depth sensor, however, makes zero-point adjustments through the automatic calibration before measurements.

6.10.2 Influence of temperature and calibration

The depth sensor depends greatly on temperature. For a wide difference between the temperature at which the sensor has been automatically calibrated and the temperature of the measurement sample, the sensor can make depth measurements with a higher accuracy by the following method:

1. **Immerse the depth sensor of the sensor probe in the sample.**
2. **Keep the sensor immersed in the sample for about 30 minutes until the temperatures of the sensor and the sample are the same.**
3. **Then make the zero calibration of the sensor manually.**

6.11 Oxidation reduction potential (ORP) measurement

6.11.1 Principle of ORP measurement

ORP is an abbreviation for oxidation-reduction potential. ORP is the energy level (potential) determined according to the state of equilibrium between the oxidants (M^{Z+}) and reductants $M^{(Z-N)+}$ that coexist within a solution.

$$M^{Z+} + ne^- \Leftrightarrow M^{(Z-N)+} \quad \cdots (1)$$

If only the solution, forming the ORP measuring system shown in Fig. 6. The difference of potential between two electrodes is generally expressed by the following equation.

$$E = E_0 - \frac{RT}{nF} \ln \frac{a_M{}^{(z-n)+}}{a_M{}^{z+}} \quad \cdots (2)$$

E: Electric potential E_0 : Constant R: Gas constant T : Absolute temperature
n: Electron count F : Faraday constant a : Activity

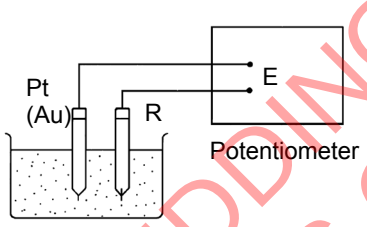


Fig. 6 Measuring mV

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For example, for a solution in which trivalent iron ions coexist with bivalent iron ions, equations 1 and 2 would be as follows.

$$Fe^{3+} + e^- \Leftrightarrow Fe^{2+} \quad \cdots (1)$$

$$E = E_0 - \frac{RT}{F} \ln \frac{a_{Fe}{}^{2+}}{a_{Fe}{}^{3+}} \quad \cdots (2)$$

When only one type of state of equilibrium uniquely by equation (Fe^{3+}) and the reductant (Fe^{2+}) (using the equation $a_{Fe}{}^{2+}/ a_{Fe}{}^{3+}$). Actually, however many kinds of states of equilibrium exist simultaneously between various kinds of ions, in most solutions. This means that under actual circumstances, ORP cannot be expressed using the simple equation shown above and that the physical and chemical significance with respect to the solution is not very clear.
In this respect, the value of ORP must be understood to be only one indicator of the property of a solution. The measurement of ORP is widely used, however, as an important index in the analysis of solutions (potentiometric titration) and in the waste water treatment.

6.11.2 Standard electrode (reference electrode) types and ORP

The ORP is obtained comparing with corresponding reference electrode employed.
If different kinds of reference electrodes are used for measurement, the ORP value of the same solution may appear to be different. HORIBA's reference electrode uses Ag/AgCl with 3.33 mol/L KCl as inner solution. According to general technical literature, normal hydrogen electrodes (N.H.E.) are often used as the standard electrode.
The relationship between N.H.E. and the ORP that is measured using an Ag/AgCl with 3.33 mol/L KCl electrode is expressed by the following equation.
$E_{N.H.E.} = E + 206 - 0.7(t - 25)$ mV t = 0 - 60°C
$E_{N.H.E.}$: Measured ORP value using N.H.E. as the reference electrode

E: Measured ORP value using Ag/AgCl with 3.33 mol/L KCl as the reference electrode
Potential sign
Standard ORP is expressed in the following way, in literature related to electrochemistry and analytical chemistry.

A $Li^+ + e^- \rightarrow Li$
$E_0 = -3.024$ V VS N.H.E.

However, in some literature, the "+" and "-" signs are reversed.

B $Li \rightarrow Li^+ + e^-$
$E_0 = +3.024$ V VS N.H.E.

In expressions like B, above, the reaction is just reversed and there is no essential difference. But this kind of expression does invite confusion. The majority of the world, today, is consistent in its use of the signs as they are used in A, above.
For this reason, HORIBA, too, uses signs concerning ORP that are consistent with A, above.

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INSTRUCTION MANUAL

pHTestr 10, 20, 30, 10BNC, Spear

Large Screen
Waterproof pH / Temperature Testr
Double Junction

Introduction

Thank you for selecting our waterproof pH Testr. This manual serves the following (5) models:

- **pHTestr 10 (Eutech PHTEST10 / 01X366901 / Oakton 35634-10)**
- **pHTestr 20 (Eutech PHTEST20 / 01X366902 / Oakton 35634-20)**
- **pHTestr 30 (Eutech PHTEST30 / 01X366903 / Oakton 35634-30)**
- **pHTestr 10BNC (Eutech PHTEST10BNC 01X366904 / Oakton 35634-14)**
- **pH Spear (Eutech PPHSPEAR 01X366920 / Oakton 35634-40)**

This manual provides a step-by-step guide to operate the Testrs.

Before you begin:

Condition your pHTestr 10, 20, 30 electrodes by immersing it in electrode storage solution or tap water for at least 30 minutes before use. DO NOT use de-ionized water.

Ensure that your pHSpear electrode is always soaked in the electrode storage solution or tap water via its protective cap.

Note: For pHTestr10BNC, please refer to the pH electrode's instruction manual.

pH Buffer Set Selection

Your Testr features USA (pH 4.01, pH 7.00 and pH 10.01) or NIST (pH 4.01, pH 6.86, and pH 9.18) standards. Select either one to suit your requirements.

1. While pressing the HOLD/ENT button, switch on the Testr by pressing the ON/OFF button.
2. Release the HOLD/ENT button. The display will flash either USA or NIST.
3. Press CAL button to toggle between the two buffer set standards.
4. Press the HOLD/ENT button to confirm the selection of the buffer set.



Figure 1: Buffer Selection Sequence

pH Calibration

Calibration should be done regularly, preferably once a week. You can calibrate up to three points using either the USA or the NIST buffer set standards.

1. Press ON/OFF button to switch unit on.
2. Dip electrode about 2 to 3 cm into the pH standard buffer solution.
3. Press the CAL button to enter calibration mode. The 'CAL' indicator will be shown. The upper display will show the measured reading based on the last calibration while the lower display will indicate the pH standard buffer solution.

Note: All Testrs have dual display during calibration mode
Note: To abort calibration, press the 'CAL' button.

4. Allow about 2 minutes for the Testr reading to stabilize before pressing the HOLD/ENT button to confirm the first calibration point. The upper display will be calibrated to the pH standard buffer solution and the lower display will then be toggling in between readings of the next pH standard buffer solution.
5. Repeat with other buffers if necessary. Rinse electrode in tap water before dipping into next buffer.

Note: The calibration mode allows you to perform up to three calibration points before returning to the measurement mode automatically. However, if you opted to have only one or two calibration points, simply skip the remaining calibration points by exiting to the measurement mode by pressing the CAL button.

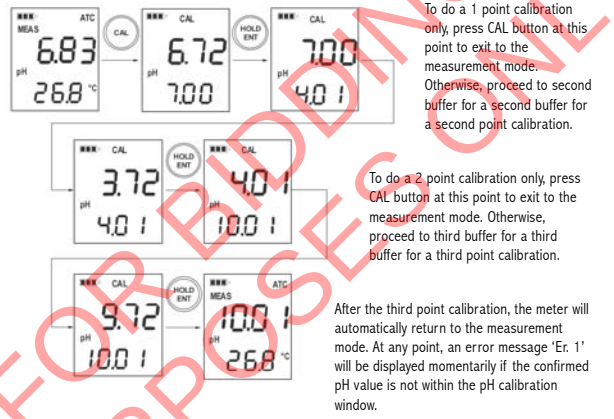


Figure 2: Example of pH Calibration Sequence

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pH Measurement

1. Press the ON/OFF button to switch the Testr on.
2. Dip the electrode about 2 to 3 cm into the test solution. Stir and let the reading stabilize. For semi-solid samples using pHSpear, rotation is ideal for sample contact. CAUTION: Testing dry samples is not accurate and can lead to sensor damage or breakage. Soils must be wet and free of particulates that may scratch the glass sensor. Excessive force into dry samples can cause glass breakage.
3. Note the pH value or press HOLD/ENT button to freeze the reading. To release the reading, press HOLD/ENT again.
4. Press ON/OFF to turn off Testr. If you do not press a button for 8.5 minutes, the Testr will automatically shut off to conserve batteries.

HOLD Function

This feature lets you freeze the display for a delayed observation

1. Press HOLD/ENT button to freeze the measurement. A 'HOLD' indicator will be displayed and the measurement will be frozen.
2. Press HOLD/ENT again to release the measurement. The 'HOLD' indicator will not be displayed anymore indicating the held measurement is released.



Figure 4: Example of HOLD Function

User Reset

You can reset the pH calibration to the factory default by using the user reset function. Buffer set selection and temperature user calibration (pHTestr30) are not affected by the user reset function.

1. Switch off the Testr.
2. While pressing the 'CAL' button, press and release the ON/OFF button to enter the 'User Reset' selection menu. The screen will display 'rSt' on the bottom display with a flashing 'nO' selection.
3. Use the 'CAL' button to toggle between 'nO' and 'YES' selection.
   - nO deactivates reset selection
   - YES activates the reset selection
4. Press the HOLD/ENT button to confirm the selection made.
5. If you have selected 'YES', the unit will show 'CO' momentarily and proceed to the measurement mode with the calibration reset back to factory default value.
6. If 'nO' is selected, the unit will proceed to the measurement mode without any calibration reset performed.

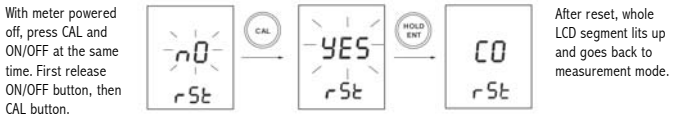


Figure 5: User Reset Sequence

ATC - Automatic Temperature Compensation (Only for pHTestr 10, pHTestr 20 and pHTestr 30)

Through its in-built temperature sensor, the measurement error due to the changes in electrode sensitivity due to changes in temperature is compensated to give the actual pH reading of the sample measured.

MTC - Manual Temperature Compensation (Only for pHTestr 10BNC, pH Spear)

The MTC range is 0 to 50.0 °C (32.0 to122.0 °F). User reset will set temperature to default value 25°C or 77°F.

While in the measurement mode,

1. Press the HOLD/ENT button to bring the Testr to the 'HOLD' mode.
2. Press the CAL button continuously to switch to the °C or °F mode setting selection screen.
3. Release the CAL button to confirm your mode selection and the display will go to the manual temperature calibration mode with the upper display flashing. The upper display shows the adjustable temperature value and the lower display shows the last set temperature offset.
4. Press the HOLD/ENT button to set the upper display to the temperature value of your sample.
5. Once the setting is reached, release the HOLD/ENT button. The new value is automatically confirmed and returns to the measurement mode if no button is pressed after 5 seconds.

Notes: To exit this program without confirming the calibration, press the CAL button before the automatic confirmation takes place.

Temperature Calibration (Only for pHTestr 30)

From the measurement mode,

1. Press the HOLD/ENT button to bring the Testr to the 'HOLD' mode.
2. Press the CAL button for 3 seconds to switch to the °C or °F mode setting selection screen. Pressing the CAL button continuously for 3 seconds allows you to toggle in between the °C and °F mode setting selection screen.
3. Release the CAL button to confirm your mode selection and the display will go to the temperature calibration mode with the upper display flashing. The upper display shows the current measured temperature reading based on the last set offset and the lower display shows the current measured temperature reading based on factory default calibration.
4. Dip the Testr into a solution of known temperature and allow time for the in built temperature sensor to stabilize.
5. Press the HOLD/ENT button to set the upper display to the temperature value of the solution.
6. Once the new temperature setting is reached, the new value is automatically confirmed and returns to the measurement mode if no button is pressed after 5 seconds.

Notes: To exit this program without confirming the calibration, press the CAL button before the automatic confirmation takes place.

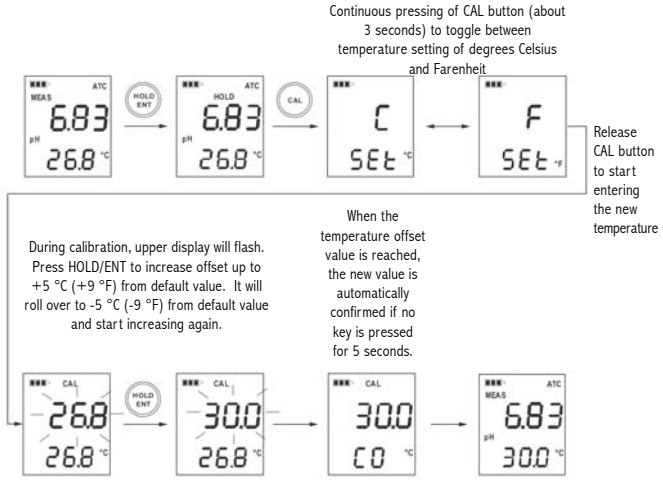


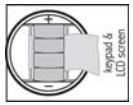
Figure 6: Temperature Calibration Sequence (Only for pHTestr 30DI)

Electrode Maintenance

1. Before measuring soil pH with the pHSpear, wet your soil sample with distilled water and ensure that the soil is free of particulates. Even though the pHSpear is ruggedized, hard surfaces such as stones and pebbles can still cause breakage.
2. Rinse the electrode with tap water or electrode storage solution after each measurement. Care has to be taken not to damage the sensor's glass electrode especially while rinsing the pHSpear penetrating tip electrode.
3. In aggressive chemicals, dirty or viscous solutions, and solutions with heavy metals or proteins, take readings quickly and rinse electrode immediately afterward. For the pHSpear, the remnants of the semi solid samples on the penetrating electrode can be removed by rubbing it with some table salt and then rinsing. Mild detergent can be used to wash the penetrating electrode clean.
4. If possible, keep a small piece of paper or sponge in the electrode cap – moistened with clean water or electrode storage solution (NOT de-ionized water) – and close the cap over the electrode. For pHSpear, ensure that the electrode is kept soaked in electrode storage solution or tap water via its protective cap.

Changing Batteries

1. Open battery compartment lid (with attached lanyard loop).
2. Remove old batteries; replace with fresh ones. Note polarity



Self-Diagnostic Messages

Low battery indicator		3 Bars indicates Battery is full (100%)
		2 Bars indicates 50% of the battery life is left
		1 Bar indicates 25% of the battery life is left
		Blinking battery casing indicates the need to replace batteries with fresh ones as specified by manufacturer
Over range / Under range signal	**Or / Ur** (Still)	Electrode is not in contact with solution or electrode is failing.
		Replacement sensor is not connected properly to the tester during sensor replacement
		Measured pH value or temperature value (pHTestr30) exceeds its specified maximum or minimum value
	ATC / Or / Ur (Blinking)	Blinking 'ATC', 'Or' or 'Ur' indicates that there is a short or open circuit at the built in temperature sensor
Error Message	**Er.0**	Temperature calibration error of attempting to calibrate tester to a value which is out of range or under range
	Er.1	pH calibration error of attempting to confirm a calibration value which is not within the specified calibration window

Electrode Replacement

You can replace the electrode module at the fraction of the cost of a new Testr. When the tester fails to calibrate or gives fluctuating readings in calibration standards, you need to change the electrode.

1. With dry hands, grip the ribbed Testr collar with electrode facing you. Twist the collar counter clockwise (see picture A). Save the ribbed tester collar and O-ring for later use.
2. Pull the old electrode module away from the Testr.
3. Align the four tabs on the new module so that they match the four slots on the Testr (see picture B).
4. Gently push the module onto the slots to sit it in position. Push the smaller O-ring fully onto the new electrode module. Push the collar over the module and thread it into place by firmly twisting clockwise.

Note: It is necessary that you recalibrate your Testr prior to measurement after an electrode replacement.

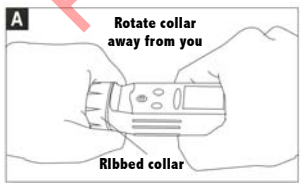


Figure 7: Removal of collar from tester

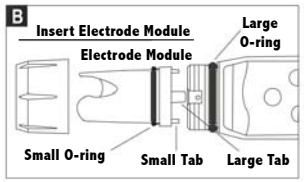


Figure 8: Example of electrode module fitting alignment

Applications

Water quality testing • pools • spas • aquariums • aquaculture • hydroponics • ecology studies • water and wastewater treatment • boilers • steam generators • car washes • sanitation plants • labs • food sectors and more!

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Warranty

The waterproof Testrs are warranted to be free from manufacturing defects for 1 year and electrode module for 6 months, unless otherwise specified. If repair, adjustment or replacement is necessary and has not been the result of abuse or misuse within the time period specified, please contact your local distributor for assistance.

Return of Items

Authorization must be obtained from your distributor before returning items for any reason. When applying for authorization, please include information regarding the reason the item(s) are to be returned.

Note: We reserve the right to make improvements in design, construction and appearance of products without notice. Prices are subject to change without notice.

Accessories

Item	Eutech Instruments Order Code	Oakton Instruments Order Code
pHTestr 10,20,30 replacement sensor	PHSENSOR03DJ	35624-38
pHSpear replacement sensor	PHSENSOR04	35634-50
Carrying Pouch pH Testr 10, 20, 30	ECPOUCH01	35624-45

Tester Specifications

Large Screen Testrs	pHTestr10	pHTestr20	pHTestr30	pHTestr 10BNC	pHSpear
pH Range	-1.0 to 15.0 pH	-1.00 to 15.00 pH			
Resolution	0.1 pH	0.01 pH			
Relative Accuracy	0.1 pH	0.01 pH			
Calibration Points	Up to 3 points	Up to 3 points			
Buffer Set Standard Selection	USA - 4.0/7.0/10.0 NIST - 4.0/6.9/9.2	USA - 4.01/7.00/10.01 NIST - 4.01/6.86/9.18			
Calibration Window (USA Buffer Set Standard)	+/-1.0 pH (pH 4.0 & pH 10.0), +/-1.5 pH (pH 7.0)	+/-1.00 pH (pH 4.01 & pH 10.01), +/-1.50 pH (pH 7.00)			
Calibration Window (NIST Buffer Set Standard)	+/-1.0 pH (pH 4.0 & pH 9.2), +/-1.2 pH (pH 6.9)	+/-1.00 pH (pH 4.01 & pH 9.18), +/-1.25 pH (pH 6.86)			
Temperature	No Display		0-50.0°C or 32.0-122.0°F		
Temperature Compensation	ATC			MTC	
Temperature Resolution	No		0.1 °C / °F		
Temperature Accuracy	No		0.5 °C / 0.9 °F	No	
Temperature Calibration Window	No		+/- (5°C /9 °F) from default value	0-50.0°C or 32.0-122.0°F (MTC)	
Auto Off	After 8.5 minutes from last key press				
User reset	Yes				
Non Volatile Memory Backup	Yes				
LCD Display	Dual				
Power Requirement	4 x 1.5V "A 76" micro Alkaline Batteries				
Battery life	More than 500 hrs				
Operating Temperature	0 – 50 °C				
Tester Dimensions	6.5 "L x 1.5"dia. (165 x 38 mm)				9.75 "L x 1.5"dia. (247 x 38 mm)
Weight	3.25 oz (90 gm)				
Penetrating electrode total length	Not applicable				91 mm
Shaft length	Not applicable				31 mm
Penetrating electrode upper diameter	Not applicable				12 mm
Shaft diameter	Not applicable				7 mm

Instruction Manual

TN-100/T-100

Portable Turbidimeter



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68X357701 Rev. 4 Apr 06

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Certificate of Compliance

This is to certify that the TN100 Portable Turbidimeter complies with the specifications established by the ISO 7027 International Standard for Water Quality - Determination of Turbidity, Section 3: Quantitative Methods using Optical Turbidimeters.



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Preface

This manual functions in two ways: first as a step by step guide to help you operate the waterproof TN-100/ T-100 turbidimeter; second, it serves as a handy reference guide.

It contains basic instructions that you must follow during the operation, care and maintenance of the instrument. The safety protection provided by this equipment may be impaired if it is used in a manner not described in this manual. It is recommended that all operators should read this manual prior to working with this instrument.

Eutech Instruments/ Oakton Instruments cannot accept any responsibility for damage or malfunction to the meter caused by improper use of the instrument.

The information presented in this manual is subject to change without notice as improvements are made, and does not represent a commitment on the part of Eutech Instruments Pte Ltd/ Oakton Instruments.

Note: Eutech Instruments Pte Ltd/ Oakton Instruments reserves the right to make improvements in design, construction, and appearance of products without notice.

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1. Overview

Thank you for selecting the waterproof portable TN-100/ T-100 turbidimeter. The TN-100/ T-100 allows you to measure turbidity of an aqueous sample in the field. This instrument operates on the nephelometric principle of turbidity measurement and is designed to meet the criteria specified in ISO 7027 and DIN 27027 standards (see Measurement Principle on page 19).

1.1 Unpacking TN-100/ T-100 Meter and Accessories

The table below indicates the items that you should find in your turbidimeter shipment.

Item	Quantity
1. Portable TN-100/ T-100 Turbidimeter with 4 “AAA” batteries	1
2. Instruction Manual	1
3. Instrument Carrying Case	1
4. Light Shield Cap	1
5. Calibration Set (0.02, 20.0,100, 800 NTU Standards)	1
6. Empty Vials	3
7. Plastic bottle (empty – for collecting sample)	1
8. Silicone Oil	1
9. Lint free cloth	1

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Remove TN-100/ T-100 turbidimeter from the packing carton. Carefully inspect all items to ensure that no visible damage has occurred during shipment. If the items you received do not match your order, please contact your nearest distributor immediately.

> ***WARNING**: Extra care should be taken when unpacking, opening, and handling the calibration standards and sample vials. Surface scratches or finger smudges on the vial surface may cause measurement errors. Handle these items by their caps only.*

Batteries provided with the meter package are to be installed prior to use. See Section 1.4 - Battery Installation on page 4.

Figure 1 depicts the meter. The three main components of the instrument are the sample well, the display, and the keypad. The following sections describe the functionality of the display and the keypad. The proper use of the instrument and the sample well are discussed in later sections.

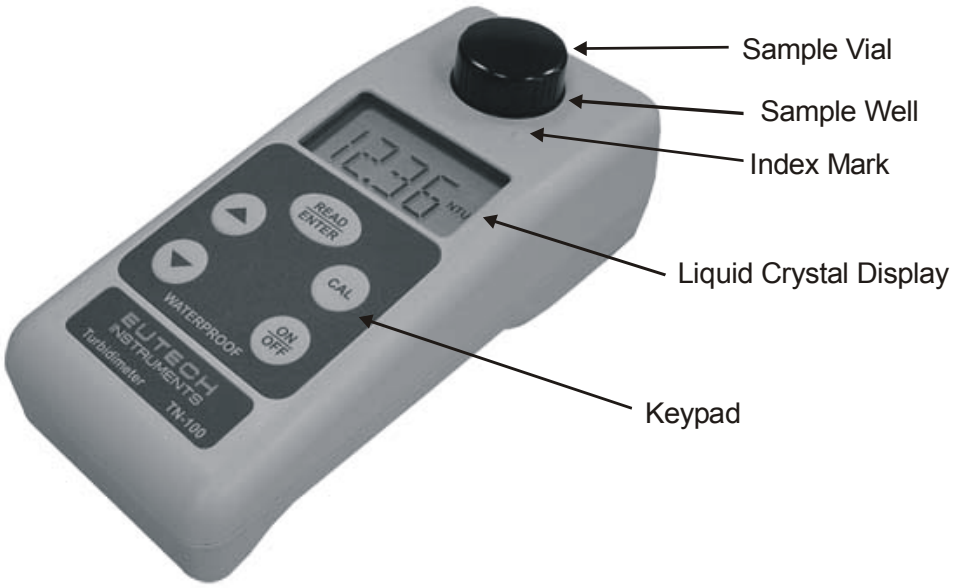


Figure 1: Parts of TN-100/T-100 Turbidimeter

1.2 Display

All the LCD segments and annunciators that can appear on the display are shown in Figure 2. The display is used for reporting the turbidity reading and to provide guidance for the operation of the instrument. In addition, the display has several other annunciators that are used to communicate error messages and provide user guidance.

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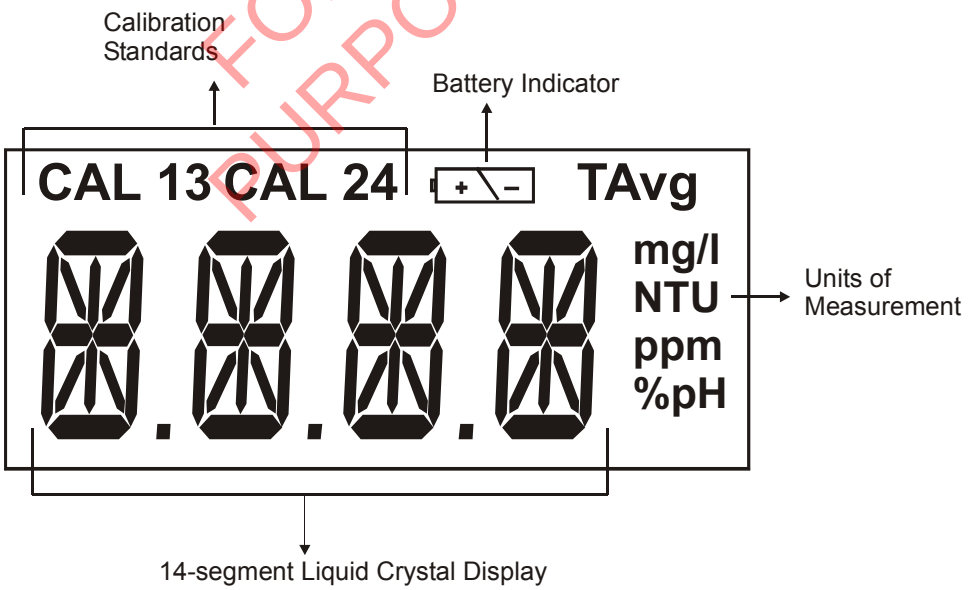


Figure 2: Customized LCD with all annunciators

1.3 Keys and Functions

The keypad has five keys: ON/OFF, CAL, ▲, ▼, and READ/ENTER.

Key	Functions
ON/OFF	Powers on and shuts off the meter. With the auto switch-off feature the meter automatically shuts off 20 minutes after last key press.
CAL	Initiates the calibration mode of the meter. When pressed, the meter is set to accept the first calibration standard. It is also used to exit the calibration mode if the user does not want to follow the complete calibration procedure.
READ/ENTER	When in measurement mode, the READ/ENTER key is used to perform a measurement. *Single-shot measurements*: When the key is pressed and released immediately (a quick key stroke of less than 0.3 seconds), the display will blink [-Rd-] for 10 times and then display the measured value. *Continuous measurements*: If the READ/ENTER key is pressed and held, the instrument will perform a continuous measurement during which the display is updated every 2 seconds. This can be used for indexing vials. (This function is not available in calibration mode). After the READ/ENTER key is released, the instrument will automatically perform a single-shot measurement.
▲ ▼	Active only during calibration mode. These keys are used to select the calibration point in an incremental/ decremental manner. *NOTE: This meter is fitted with an auto incrementing feature, i.e. after the successful calibration of one point it auto selects the next calibration point, or automatically exits the calibration mode after the fourth calibration point.*

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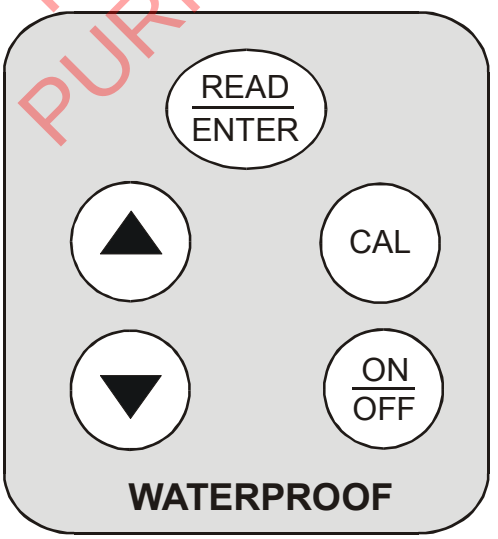
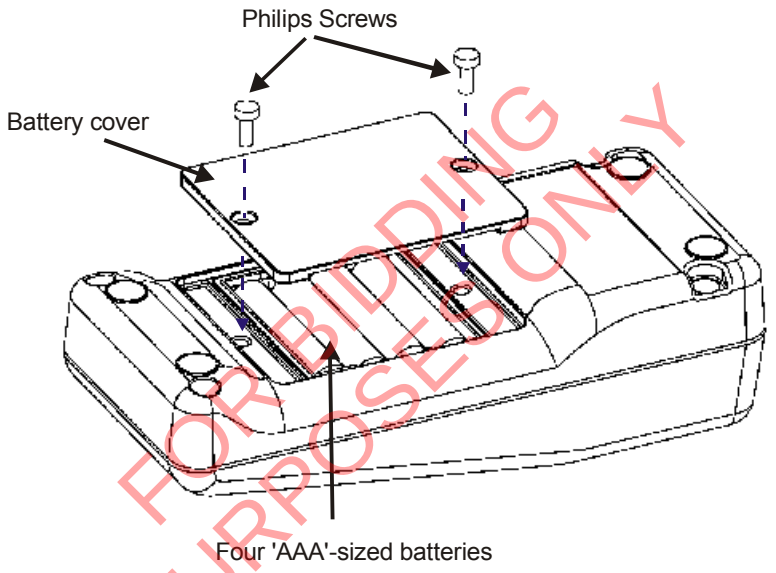


Figure 3: Keypad

1.4 Battery Installation

Four AAA-sized batteries are included in the packaging:

1. Use a Philips screwdriver to remove the two screws holding the battery cover. See Figure 4.
2. Remove the battery cover.
3. Insert the batteries. Follow the diagram inside the cover for correct polarity.
4. Replace the battery cover onto its original position using the two screws removed earlier.
5. The meter is now ready to operate.



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Figure 4: Battery Installation

NOTE: *Dispose used batteries in accordance with your local regulations.*

2. Turbidity Calibration

The TN-100/ T-100 turbidimeter was calibrated and tested prior to leaving the factory. Therefore, it is possible to use the instrument directly out of the box. However, re-calibration of the instrument is recommended to help you become familiar with the operation of the instrument and the calibration procedures. In addition, re-calibration is recommended at least once every month for optimum accuracy.

It is recommended that you perform a full calibration using all 4 standards provided to ensure full-range accuracy. However, the TN-100/ T-100 turbidimeter provides flexibility for you to calibrate at selected ranges suitable for your application.

In addition, the instrument comes with a light shield cap to shield off stray light during calibration and measurements.

2.1 Calibration Standards

We recommend that you use the following materials during calibration to achieve the accuracy stated in this manual:

- **CAL 1**: 800 NTU Calibration Standard
- **CAL 2**: 100 NTU Calibration Standard
- **CAL 3**: 20.0 NTU Calibration Standard
- **CAL 4**: 0.02 NTU Calibration Standard

It is well known that diluted Formazin is unstable. If you choose to use Formazin to calibrate the instrument, ensure that you are using a fresh stock suspension of Formazin to achieve the accuracy quoted for the instrument. Calibration standards offered are more stable than Formazin and have a limited shelf life of 12 months. If you use the supplied calibration standards to calibrate the instrument, review the expiration date (indicated on cap label) to ensure that the standards have not expired.

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It is important that the calibration standards are not violently shaken or agitated because air entrapment in the fluid introduces an error factor during calibration which subsequently will lead to an inaccurate measurement. Also, do not store in freezing temperatures which causes irreversible shrinkage of the standards' particles thus resulting to inaccurate calibration and measurement.

2.2 Indexing

Due to the high quality of the glass vials provided, indexing is not required. You only need to align the mark on the vial with the mark on the meter. However, in order to achieve a better accuracy of the measurement, you can proceed with indexing of the vials. See Section 8.5 - Indexing a Vial on page 20 for more information.

2.3 Calibration Procedure

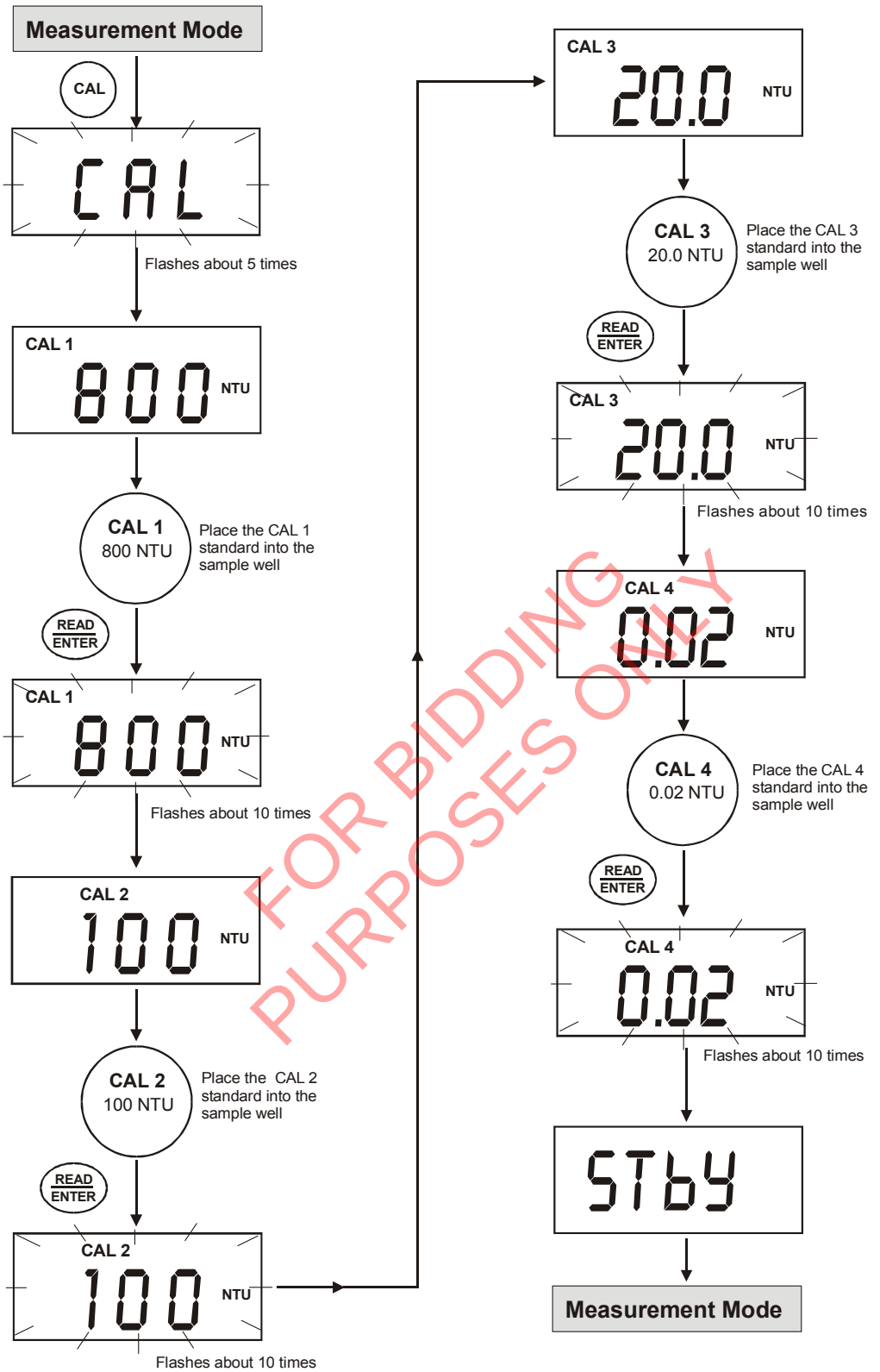
1. Place TN-100/ T-100 turbidimeter on a flat and level surface.
2. Insert the CAL 1 standard (800 NTU) into the sample well, aligning the mark on the vial with the mark on the meter. See **Figure 10** on page 12.
3. Press down vial until it snaps fully into the instrument.
4. Cover the vial using the light shield cap.
5. Press **ON/OFF** key to switch the on the meter. The meter goes to measurement mode after the power-up sequence.
6. Select the calibration function of the instrument by pressing the **CAL** key once. The "CAL" annunciator blinks momentarily and the meter prompt for the first calibration standard "CAL 1 800 NTU".
7. Press **READ/ENTER** key.
8. The "CAL 1 800 NTU" annunciator blinks for about 12 seconds while the instrument performs calibration of CAL 1 point. When the instrument has completed calibration for this point, it prompts you to insert the next calibration standard into the sample well "CAL 2 100 NTU".
9. Repeat the calibration for CAL 2, CAL 3 & CAL 4 calibration standards.
10. After you successfully calibrate the CAL 4 standard (0.02 NTU), the display shows "STbY".
11. The meter is now ready for measurement.

Figure 5 shows the complete calibration sequence.

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NOTES:

1. *If you wish to exit the calibration mode you may do so at the end of any step by pressing the **CAL** key. The meter accepts only the values calibrated prior to exiting.*
2. *You can skip a calibration point by pressing ▲ or ▼ keys and move on to the next calibration point.*
3. *After a successful calibration of one point, the meter automatically selects the next calibration point. The meter automatically exits calibration mode after the fourth calibration point.*
4. *If an error occurs during calibration, the display shows an error message. The meter aborts calibration and returns to the measurement mode without saving the last calibration value.*
5. *For a list of error messages, refer to Section 4: Troubleshooting Guide on page 15.*



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Figure 5: Calibration Sequence

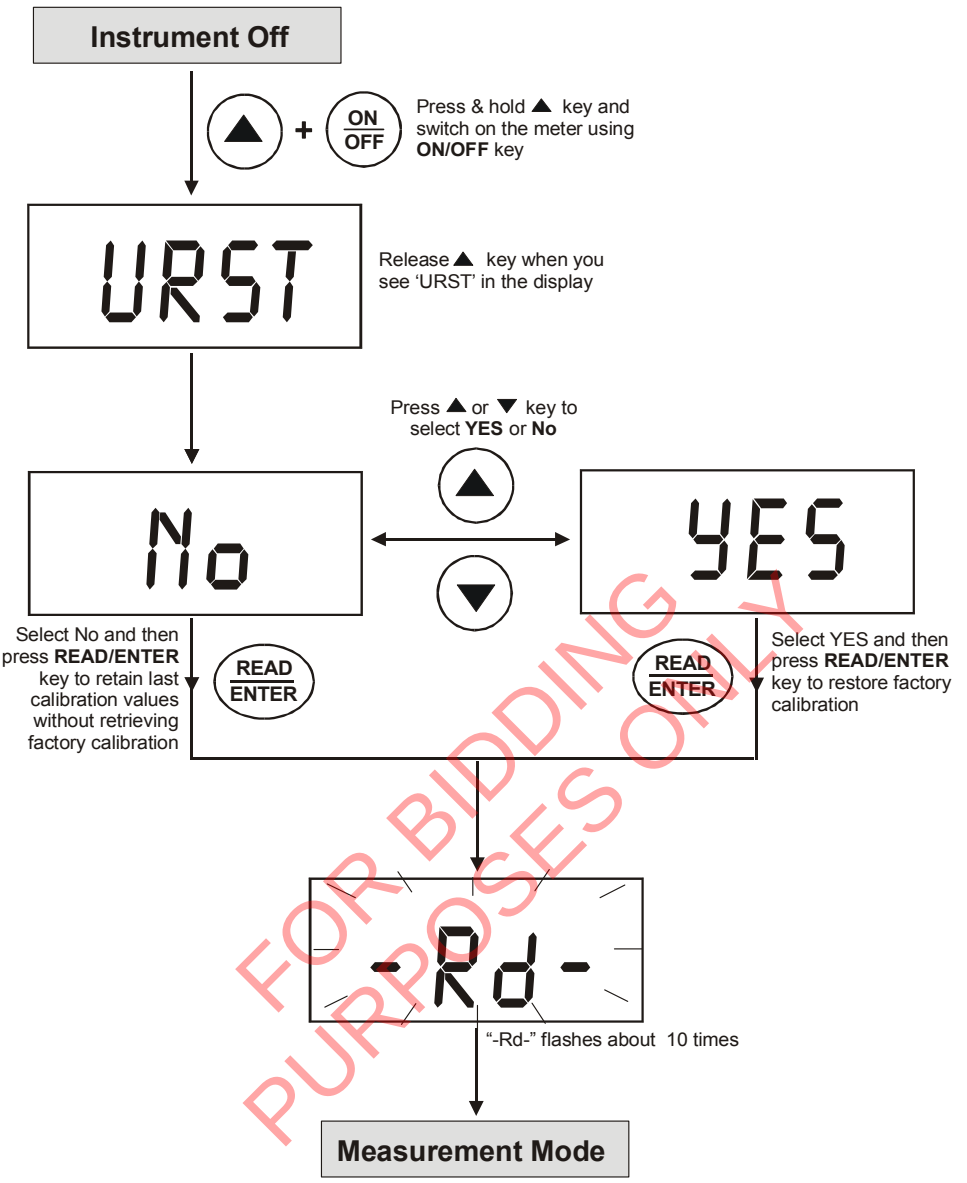
2.4 Restoring Factory Calibration

The TN-100/ T-100 turbidimeter allows you to reset the meter back to the factory default calibration values. This feature is extremely useful when there are errors in calibration or when you have new calibration standards.

1. With the meter switched off, press and hold ▲ key.
2. Switch on the meter using **ON/OFF**. Release ▲ key when “URST” (User-Reset) appears in the display.
3. The display shows “URST” for about 2 seconds and then shows “No”.
4. Use ▲ or ▼ key to select between “YES” or “No”.
    - **YES** = To restore meter back to factory calibration values
    - **No** = To retain last calibrated values
5. Press **READ/ENTER** key to confirm your selection. The meter performs the reset if “YES” is selected.
6. The display flashes “--Rd—“about 10 times indicating that the meter goes to measurement mode.

Figure 6 shows the sequence for restoring factory calibration values.

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Figure 6: Restoring Factory Calibration

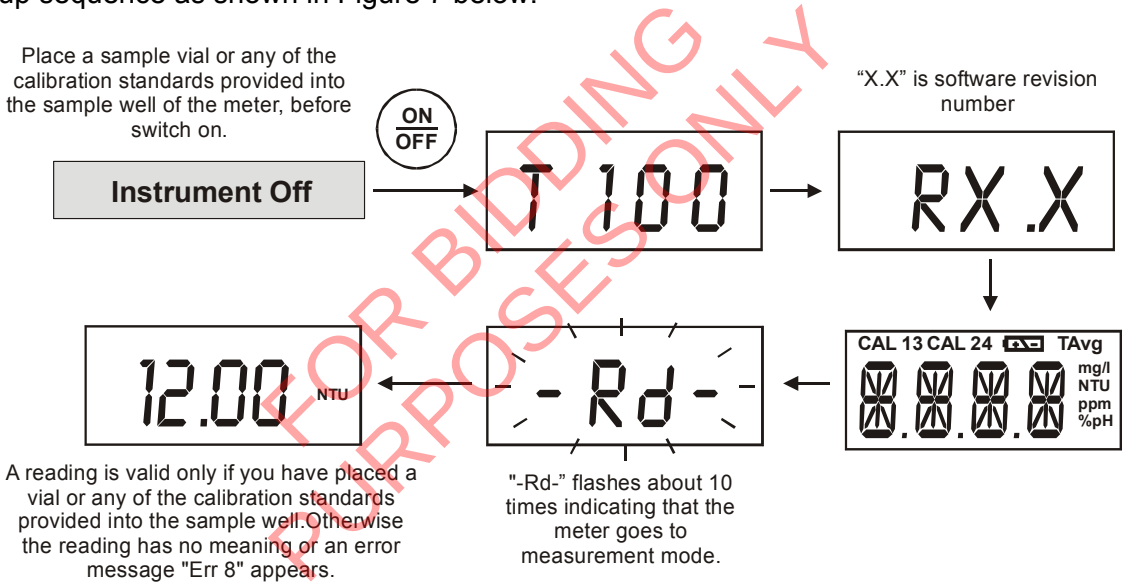
3. Turbidity Measurement

3.1 General Information

The waterproof TN-100/ T-100 turbidimeter allows you to measure the turbidity of a grab sample. The turbidity is reported in Nephelometric Turbidity Units (NTU). Readings above 1000 NTU are outside the range of this instrument.

> ***NOTE:*** *Before switching on the TN-100/ T-100 turbidimeter, a sample vial MUST be placed in the sample well. You can use any of the calibration standards for this purpose.*
>
> *The light shield cap provided could be used to cover the vial during measurements.*

When the **ON/FF** key is pressed to switch on the meter, it goes through the power-up sequence as shown in Figure 7 below.



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Figure 7: Power-up Sequence

3.2 Turbidity Measurement Procedure

An accurate turbidity measurement depends on good measurement techniques. Factors such as clean sample vials, positioning of vial in the sample well, covering the vial with the light shield cap, meter calibration, handling of meter, and others, have to be taken into consideration. Please see the following sections for more information.

Section 5.1: Vials – Handling, Cleaning and Care (page 16)

Section 9: Addendum 2:
Guide to Good Measurement Technique (page 21)

Preparation of Sample Vial

1. Obtain a clean and dry sample vial
2. Take care to handle the sample vial by the top.
3. Rinse the vial with approximately 10 ml of the sample water, capping the vial with the black screw cap and gently inverting it several times. Discard the used sample and repeat the rinsing procedure two more times.
4. Fill the rinsed vial with the remaining portion (approximately 10 ml) of the grab sample up to the mark indicated in the vial. Cap the vial with the supplied black screw cap.
5. Wipe the vial with the soft, lint-free cloth supplied. Ensure that the outside of the vial is dry, clean and free from smudges.

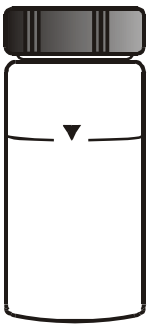


Figure 8: Sample Vial

6. Apply a thin film of silicone oil (supplied) on the sample vial (see Figure 9).
7. Wipe with a soft cloth to obtain an even distribution over the entire vial's surface.

NOTES:

1. *The purpose of oiling the vial is to fill small scratches and to mask the imperfection in the glass.*
2. *Do not apply large quantity of oil as this may collect dirt and dust*

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8. The sample vial is now ready to be inserted into the sample well of the meter for measurement.

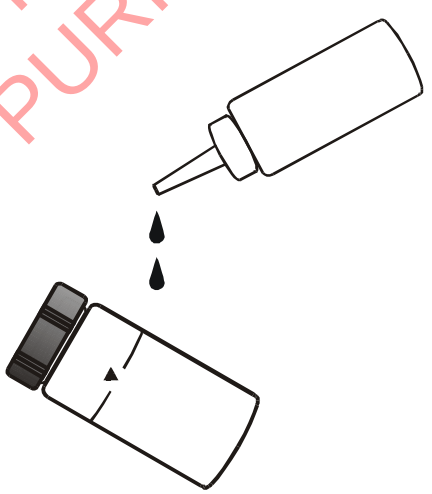


Figure 9: Apply a thin film of silicon oil

Measurement Procedure

1. Place TN-100/ T-100 turbidimeter on a flat and level surface.
2. Place the sample vial inside the sample well and align the vial's index mark with the meter's index mark. See **Figure 10**.

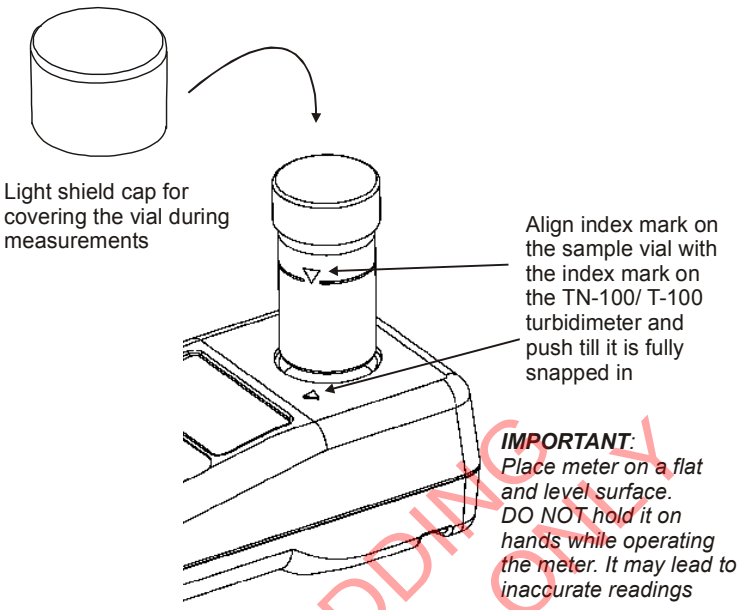


Figure 10: Align sample vial's index mark with meter's index mark

3. Push the vial until it is fully snapped in.
4. Cover the vial with the light shield cap.
5. Turn on the meter by pressing the **ON/OFF** key.
6. After the power-up sequence, the meter goes to measurement mode and the display blinks "--Rd--" for about 10 times. See Figure 11.
7. The measured reading appears in the display.
8. If necessary, place the second sample vial into the sample well. Remember to align the vial's mark with the meter's index mark.
9. Press **READ/ENTER** key. The display blinks "--Rd--" for several times and measured reading appears.
10. Repeat steps 2 through 9 for all of your samples.

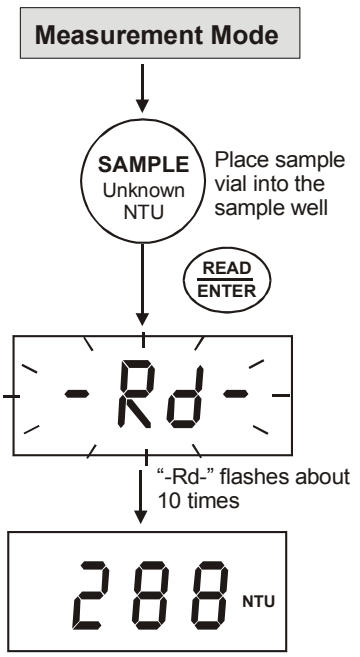


Figure 11: Reading Turbidity Value

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NOTES:

1. *NEVER pour liquid directly into the sample well of the instrument. Always use a vial. The instrument will only accurately measure the turbidity of a sample when vials sealed with the black caps are used. The black cap serves as both seal and a light shield.*

2. *NEVER attempt to clean the sample well. The optics may be damaged.*

3. *For battery conservation, the instrument automatically powers off 20 minutes after the last key pressed.*

3.3 Single-Shot or Continuous Measurement

You can use TN-100/ T-100 turbidimeter to take a single reading or perform continuous measurement. The latter is only used for indexing the vials. See **Section 8.5** - Indexing a Vial on page 20 for more information.

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For Single-shot Measurement:

1. Make sure the meter is sitting on a flat and level surface and is in measurement mode. The display shows the last measured value or “STbY” after exiting calibration mode.
2. Place sample vial in the sample well.
3. Cover the vial with the light shield cap.
4. Press **READ/ENTER** key and release immediately (<0.3 seconds). See Figure 12.
5. The display blinks “--Rd--“ for about 10 times and then display the measured value.

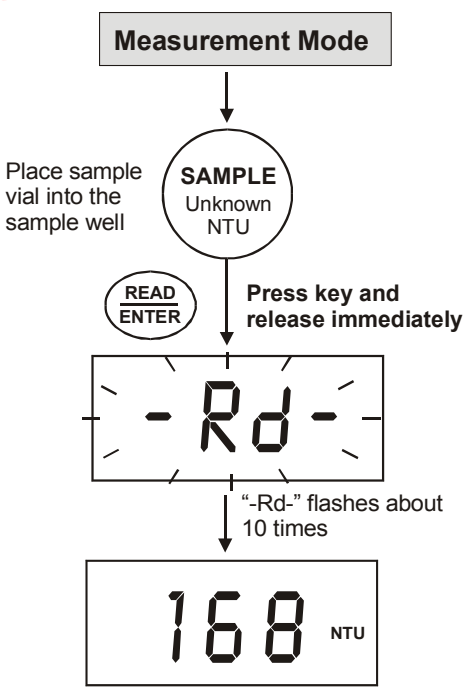


Figure 12: Single-shot Measurement

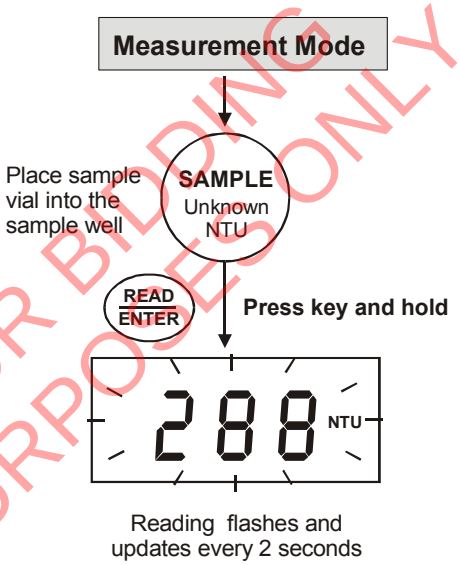
For Continuous Measurement:

1. Make sure the meter is sitting on a flat and level surface and is in measurement mode. The display shows the last measured value or “STbY”
2. Place the sample vial in the sample well.
3. Press **READ/ENTER** key and hold. See Figure 13
4. Wait for the reading to stabilize before rotating the sample vial.

NOTE: *During continuous measurement, the display is updated every 2 seconds. The displayed reading may not be the actual turbidity value. For accurate measurement, use single-shot measurement.*

You can rotate the sample vial for indexing purpose. See **Section 8.5** - Indexing a Vial on page 20 for more information.

5. Once you release **READ/ENTER** key, the meter automatically performs a single-shot measurement.



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Figure 13: Continuous Measurement

NOTES:

1. *After a measurement is completed and the display is updated, a 4-second recovery time occurs before the meter can perform another function. If any key is pressed during the recovery time, the meter will perform the corresponding action at the end of the recovery period.*

2. *When performing a measurement, if the meter detects stray light exceeding the amount equivalent to 0.02 NTU in the low range, the measurement is immediately aborted and an error message [ERR 8] is displayed. Ensure the vial sits properly into the sample well. Press the ENTER/READ key to re-do the measurement.*

4. Troubleshooting Guide

The TN-100/ T-100 turbidimeter routinely performs self-diagnostics, and will automatically generate messages to provide you with specific diagnostic information. These messages are for your use and do not indicate a reduction in the performance of the instrument or a failure of any component in the instrument, unless otherwise stated in this list.

LCD Message	Description	Corrective Actions
ERR 1	Calibration Error. The meter is unable to recognize the 800 NTU Calibration Standard.	Ensure to use the correct 800 NTU calibration standard. *
ERR 2	Calibration Error. The meter is unable to recognize the 100 NTU Calibration Standard.	Ensure to use the correct 100 NTU calibration standard. *
ERR 3	Calibration Error. The meter is unable to recognize the 20.0 NTU Calibration Standard.	Ensure to use the correct 20.0 NTU calibration standard. *
ERR 4	Calibration Error. The meter is unable to recognize the 0.02 NTU Calibration Standard.	Ensure to use the correct 0.02 NTU calibration standard. *
ERR 5	Calibration Error. There is not sufficient signal to achieve the appropriate resolution in the 0-1000NTU range.	Re-do calibration with all 4 standards provided. *
ERR 6	General Calibration Failure. There is not sufficient signal to achieve the appropriate resolution in the 0-100NTU range.	Re-do calibration with all 4 standards provided. *
ERR 7	General Calibration Failure. There is not sufficient signal to achieve the appropriate resolution in the 0-20 NTU range.	Re-do calibration with all 4 standards provided. *
ERR 8	Excessive stray light detected.	Ensure the vial is fully snapped in the sample well.
	Attempting a measurement when low battery indicator is on.	Replace batteries.
ERR 9	Lamp Failure.	Return unit.
Or	When Turbidity value is above the measurement range(>1000NTU)	Dilute sample. See Section 9.7 on page 23.
	Low battery indication. The batteries need to be replaced.	Replace batteries.

* If an error message appears, take the appropriate corrective action and re-do the desired procedure. If the problem persists, contact Eutech Instruments or your dealer. See Sections on Warranty and Return of Items on page 24.



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5. Routine Maintenance

The supplied carrying case is optimal for protecting the instrument. If you do not plan on leaving the instrument in the supplied carrying case, when not in use, ensure that the instrument has been turned off and that a clean sample vial fitted with a black cap has been placed in the sample well. This will ensure that a minimal amount of dust and/or debris will be able to settle on the optics of the instrument.

5.1 Vials – Handling, Cleaning and Care

Proper measurement of the turbidity of a sample requires the use of a vial that is free of marks, smudges, scratches and any bacterial growth.

Therefore, sample vials must be handled with absolute care to avoid contamination or damage, which might change the optical characteristics of the glass. Scratches, fingerprints, and water droplets on the sample vial or inside the sample well can cause stray light interference leading to inaccurate readings.

Cleaning the vial is accomplished by washing the interior and exterior of the vial in a detergent solution. Once cleaned, the vial should be rinsed thoroughly 8 to 10 times with clean distilled water to eliminate the possibility of detergent buildup and streaking.

Vials can also be acid washed periodically and coated with a special silicone oil to fill small scratches and mask the imperfections in the glass. Since the silicone oil required for this application should have the same refractive characteristics as glass, it is recommended that the oil be obtained from us. Care should be taken not to apply excessive oil that could attract dirt or contaminate the sample well of the meter. Once the oil has been applied to the vial, the excess oil should be removed with a lint-free cloth. The result should be a sample vial surface with a dry appearance, but with all imperfections filled with oil.

Sample vials should always be handled from the top or by the cap to avoid fingerprints or smudges. After a vial has been filled with a sample and capped, the outside surface should be wiped with a clean, lint-free absorbent cloth until it is dry. Cleaned and dried vials should be stored with the black caps on. The vials can be stored in the carrying case. During normal operation you may use any typical glass cleaner along with a lint free cloth or tissue (Kimwipes®), to clean the outside of the vials.

Condensation may appear on the vial when your sample is very cold and the relative air humidity is high. When this happens, the turbidity that you read may be higher than the actual turbidity due to the light scattered by the condensate on the vial. If you find yourself in this circumstance, you can alleviate the problem by either coating the vial with an anti-fogging agent, or by running warm water over the vial for a short period of time to warm the sample prior to measurement.

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6. Accessories

The items shown below are recommended accessories and replacement parts for the instrument.

Item Description	Eutech Instruments Order Code	Oakton Instruments Order Code
Waterproof TN-100/ T-100 portable turbidimeter with set of 4 calibration standards (800, 100, 20.0 & 0.02 NTU), set of 3 sample vials, lint-free cloth, silicone oil, batteries – all in a rugged carrying case.	EC-TN100	35635-00
Calibration Set for normal operation (includes 800, 100, 20.0 & 0.02 NTU Standards)	ECTN100CALKT	35635-50
Sample Vials – pack of 3 vials	ECTN100CUVKT	35653-55
Silicone Oil – 10ml	ECSILICONEOIL	~

To order any accessory or replacement part, please contact the nearest distributor or Eutech Instruments/ Oakton Instruments.

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7. Specifications

Parameter	Specification
Measurement Method	ISO 7027 compliant nephelometric method (90°)
Measurement Range	0 to 1000 NTU
Automatic Range Selection	0.01 – 19.99 NTU 20.0 – 99.9 NTU 100 – 1000 NTU
Resolution	0.01 NTU (0 – 19.99 NTU) 0.1 NTU (20 – 99.9 NTU) 1 NTU (100 – 1000 NU)
Accuracy	±2% of reading ± 1 LSD for 0 to 500 NTU; ±3% of reading ± 1 LSD for 501 to 1000 NTU.
Repeatability	± 0.01 NTU or ± 1% of reading, whichever is greater with gel samples
Response Time	< 6 seconds for full step change
Calibration Standards	0.02 NTU; 20 NTU; 100 NTU; 800 NTU
Standardization	EPA-approved polymer-based primary standards
Light Source	Infrared-emitting diode (850 nm wavelength)
Light Source Life	> 1,000,000 tests
Detector	Silicon photovoltaic
Stray Light	< 0.02 NTU
Display	4-digit 14-segments customized liquid crystal display with annunciators
Sample Cells (Vials)	Borosilicate glass with screw caps, fill line and indexing mark. 51 (H) x 25 (Dia) mm (2 x 1 in)
Sample Volume Required	10 ml (0.33 oz)
Operating Temperature Range	0°C to 50°C (32°F to 122°F)
Sample Temperature Range	0°C to 50°C (32°F to 122°F)
Operating Humidity Range	0-90% RH, non-condensing at 30°C (86°F)
Power Supply	4 x “AAA” Alkaline Batteries
Battery Life	> 1200 readings
Enclosure Type & Rating:	ABS Plastic / IP67 rated
Insulation Rating	Pollution Degree 2
Weight:	Meter: 200 g (7 oz) Meter with case: 1.25 kg (2.75 lb)
Dimensions	Meter: 6.8 (W) x 15.5 (L) x 4.6 (H) cm; (2.7 x 6.1 x 1.8 in) Meter with Case: 16 (W) x 35 (L) x 12 (H) cm; (6.3 x 13.8 x 4.7 in)

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8. Addendum 1: Turbidity

8.1 Definition

Turbidity is defined as an "*expression of the optical property that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample.*"[1] That is, turbidity is the measure of relative sample clarity, not colour.

Water with cloudy or opaque appearance will have high turbidity, while water that is clear or translucent will have low turbidity. High turbidity value is caused by particles such as slit, clay, microorganisms, and organic matter. By definition, turbidity is not a direct measure of these particles but rather a measure of how these particles scatter light.

8.2 Why Is It Important?

For drinking water application, a turbidity value may give an indication of presence of bacteria, pathogens, or particles that can shelter harmful organisms from disinfection process. Therefore, turbidity measurement is particularly useful for water treatment plants to ensure cleanliness.

In industrial processes, turbidity can be part of quality control measure to ensure efficiency in treatment or manufacturing process.

8.3 Measurement Principle

There are two internationally accepted standard specifications for turbidity measurement. These are the international standard ISO 7027 and the US EPA method 180.1.

Basically the ISO 7027 is a more stringent standard and requires the use of a monochromatic light source. It also governs the design of a turbidimeter in the following areas: (1) Light source's wavelength; (2) Light sources' spectral bandwidth; (3) Measuring angle; (4) Aperture angle in water sample; (5) Distance traversed by incident light and scattered light within the sample; (6) Calibration standard.

The TN-100/ T-100 turbidimeter follows the ISO 7027 standard whose specification allows for greater reproducibility of the measured values and greater agreement between other measuring instruments.

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[1] Provided by "Standard Methods for the Examination of Water and Wastewater, APHA, AWWA and WPCF, 16th Edition, 1985.

Figure 14 shows the waterproof TN-100/ T-100 turbidimeter basic optical system. It includes a light source and a detector to monitor the light scattered at 90° with respect to the incident beam.

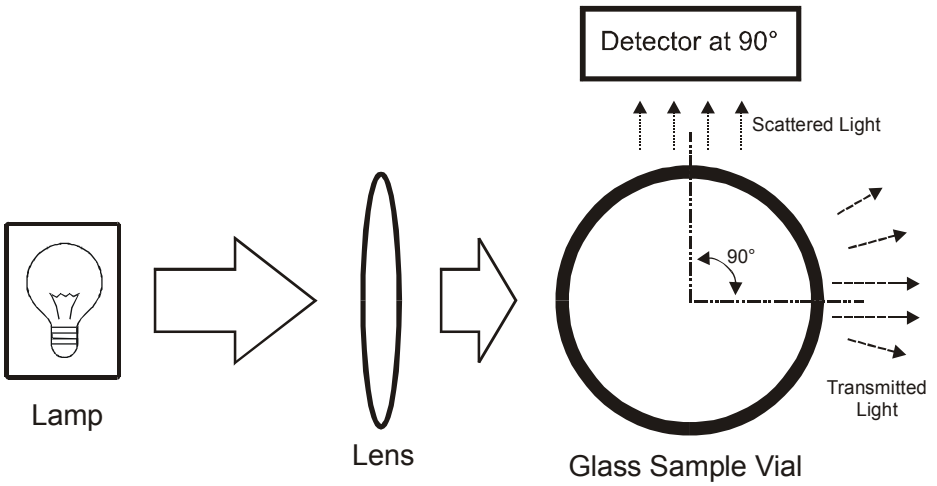


Figure 14: Basic Nephelometric arrangement for turbidity measurement

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8.4 Nephelometric Turbidity Units (NTU)

Nephelometric Turbidity Units (NTU): Unit of measure used when relating the light scattered by a liquid media to the light scattered by a known concentration of a standard solution. This unit of measure is recognized as a measure of the optical clarity of an aqueous sample. NTU is the accepted unit of measurement for turbidity.

Another unit commonly used to measure turbidity is Formazin Turbidity Unit (FTU). The two units of measure of turbidity are equivalent: 1 NTU = 1 FTU.

8.5 Indexing a Vial

The United States Environmental Protection Agency (US EPA) recommends that vials used for turbidimeter calibration or sample measurement be indexed.

To index a sample vial, slowly rotate the vial throughout one complete revolution (360°). While rotating the sample vial, observe the display and locate the position that the vial is in which provides the lowest turbidity reading. This position is the indexed position of the vial.

Mark this position on the vial (not on the cap) against the mark on the meter.

After indexing a vial, make sure the vial will always be placed inside the sample well in the indexed position.

9. Addendum 2: Guide to Good Measurement Technique

Turbidity is a very complex analytical measurement which can be affected by many factors. Some are inherent in the instrument's design such as angle of detection, light beam aperture, incident beam wavelength and color sensitivity of the photocell.

However, there are other factors such as stray light, air bubbles and care of vial, which can be prevented through proper care of equipment and accessories, and in the operating procedure for measurement. Here are some points you may want to note:

9.1 Maintain sample vials in good condition

Sample vials must be meticulously clean and free from significant scratches. It should be treated on the outside with a thin coat of silicone oil. This is to mask minor imperfections and scratches that may contribute to stray light. Sample vials should be handled only by the top to avoid dirt accumulation (or deposits) and fingerprints that might interfere with the light path.

More information is found in Section 5.1 - Vials – Handling, Cleaning and Care on page 16.

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9.2 Match Sample Vials

Best accuracy and repeatability of turbidity measurement are achieved using a single, indexed vial. However, for more convenience, different vials can be used for measurement provided their readings with the same solution are matched. That is, the meter gives identical readings or within the specified repeatability and accuracy of the meter.

Select a few vials. After the sample vials are cleaned, fill them with ultra-low turbidity water. Allow the sample vials to stand and for air bubbles to rise. Polish sample vials with silicone oil and take turbidity measurement at several points while rotating it in the sample well. Find the position where turbidity reading is the lowest and index it for each vial. Whenever these sample vials are used, use the indexed mark to position each vial into the sample well. Choose those vials that match the readings.

NOTE: *Not all vials can be matched because of some manufacturing variations.*

9.3 Degassing

Air or other trapped gases should be removed before measurement. Degassing is recommended even if no bubbles are visible. There are three methods commonly used for degassing:

- Addition of a surfactant: This involves adding a surfactant to the water samples to lower the surface tension of the water, thereby releasing trapped gasses.
- Application of a partial vacuum: Partial vacuum can be created by using simple syringe or vacuum pump. (This is only recommended for ultra-low turbidity measurement).
- Use of an ultrasonic bath: This may be effective in severe conditions or in viscous samples, but not recommended for ultra-low measurements.

Each of the method above has its own advantages and disadvantages. For instance, under certain sample conditions, the use of vacuum pump or ultrasonic bath may actually increase the presence of gas bubbles.

9.4 Timeliness of Sample

Samples should be measured immediately to prevent changes in particle characteristics due to temperature and settling. Temperature can affect particles by changing their behavior or creating new particles if precipitates are formed. Dilution water may dissolve particles or change their characteristics. It is recommended to take samples only when the turbidimeter is ready to be operated. Samples should not be drawn and allowed to sit while the instrument warms up or is being readied.

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9.5 Other Important Sampling Techniques

1. Samples should not be violently shaken or agitated as particles can be broken apart or air may be entrapped into the fluid. Gentle agitation such as swirling the sample vial is advisable to reduce particle settling.
2. Sample vials should be used only with the instruments for which they were intended. Do not mix and match.
3. Perform a visual observation of the sample vial every time a measurement is made. Ensure that there are no visible bubbles in the sample and the vial is clean and free of scratches.
4. Samples entering the turbidimeter should be at the same temperature as the process flow samples. Changes in temperature can cause precipitation of soluble compounds and affect readings.
5. Sample vials should be evaluated with a low turbidity water (after cleaning) to determine if cells remain matched. If the evaluation determines that a cell is corrupted, discard the vial. It is recommended to conduct this evaluation weekly.
6. When in doubt or question about whether a sample vial is too scratched or stained, throw it away.

9.6 Calibration

1. Do not open the vials with calibration standards.
2. Check that the standards have not expired.
3. Make sure the calibration vials are free of dust, smudges and scratches before use.
4. Conduct the calibration in the same manner each time. Variations in how calibration is performed could yield inaccurate measurements.
5. It is very important that the user(s) who perform calibration have been trained to do so. Creating a Standard Operating Procedure (SOP) for the user(s) to read, learn, and practice may help to ensure accuracy.

9.7 Dilution

This dilution procedure is necessary only when your turbidity measurement is above 1000 NTU.

1. To measure the turbidity above 1000 NTU, dilute the sample with turbidity-free water.
2. Turbidity-free water can be obtained by filtering deionized water through a < 0.2µm filter membrane with precision-sized pores.
3. Measure the volume of the sample before dilution and record the value in ml (Vs).
4. Take a known volume (Vd) of dilution water and add it to the sample.
5. Pour 10 ml of the diluted sample in a clean vial and measure the turbidity of the diluted sample. Record this value in NTU (Td).
6. Calculate the true turbidity (T) of the original sample - in NTU - using the following formula:

$$T = Td * (Vs + Vd) / Vs$$

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Example:

- Dilute 20 ml of the original sample (whose turbidity is above 1000NTU) with 50 ml of dilution water.
- Measure the turbidity of the diluted sample.
- If the reading is 300 NTU, the turbidity of the original sample is 1050 NTU. (In this case: Td=300NTU, Vs=20ml, Vd=50ml, so T = 300 * (20+50) / 20 = 300*70/20 = 21000/20 = 1050)

10. Warranty

The TN-100/ T-100 meter is supplied with a **2-year** warranty from manufacturing defects and calibration standards for **6 months**.

If repair or adjustment is necessary and has not been the result of abuse or misuse within the designated period, please return – freight pre-paid – and correction will be made without charge. Eutech Instruments/ Oakton Instruments will determine if the product problem is due to deviations or customer misuse.

Out of warranty products will be repaired on a charged basis.

Exclusions

The warranty on your instrument shall not apply to defects resulting from:

- Improper or inadequate maintenance by customer
- Unauthorized modification or misuse
- Operation outside of the environment specifications of the products

Waterproof Seal: Opening the instrument enclosure (excluding the battery compartment) may void the warranty.

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11. Return of Items

Authorization must be obtained from our Customer Service Department or authorized distributor before returning items for any reason. A “Return Goods Authorization” (RGA) form is available through our Authorized Distributor. Please include data regarding the reason the items are to be returned. For your protection, items must be carefully packed to prevent damage in shipment and insured against possible damage or loss. Eutech Instruments/ Oakton Instruments will not be responsible for damage resulting from careless or insufficient packing. A restocking charge will be made on all unauthorized returns.

NOTE: *Eutech Instruments Pte Ltd/ Oakton Instruments reserve the right to make improvements in design, construction, and appearance of products without notice.*

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For more information on Eutech Instruments/ Oakton Instruments' products, contact your nearest distributor or visit our website listed below:

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Appendix H: Supplemental Information

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