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Section 19-16 This nSSP is used for trenchless excavation and installation of culvert or pipeline.

Payment for work under this section is included into LF of corresponding culvert or pipeline. Follow instructions for bid items included in drainage nSSPs.

The nSSP is performance based and method independent.

To protect Caltrans asset, the pavement and buried utilities, the nSSP implements 3 monitoring regimes:

1. Pavement smoothness monitoring

2. Ground surface movement monitoring

3. Subsurface movement monitoring

Pavement smoothness monitoring is required (pre-, post-, and monthly) if:

1. Annual Average Daily Traffic ≥ 100,000, [AADT ≥ 100,000], and

2. Minimum vertical distance between pavement surface and the top of bore (H) is less than 8 times the bore diameter (DB) [H < 8 DB].

Ground surface movement monitoring is always required.

1. For [AADT ≥ 100,000]: monitor based on digital surface model that will not affect traffic. (pre-, post-, weekly)

2. For [AADT < 100,000]: survey with level and rod that may need traffic control. (pre-, post-, daily)

Subsurface movement monitoring at 6 feet above the bore is required to detect hidden voids if:

1. Annual Average Daily Traffic ≥ 100,000, [AADT ≥ 100,000],

2. Bore diameter is greater than 48 inches [DB > 48”], and

3. Minimum vertical distance between pavement surface and top of culvert is less than 8 times the bore diameter [H < 8 DB].

Overcut must be less than

1. 1 inch or less than 5% of the culvert or pipeline outside radius, whichever is less.

2. 2 inches for trenchless construction using horizontal directional drilling method.

To facilitate broadband conduit installation, the requirement is relaxed for Horizontal Directional Drilling, which is typically used for conduit installation. HDD produces greater overcut than other construction methods. The requirement is formulated to discourage the use of HDD for pipeline with outside diameter greater than 8”.

Replace section 19-16 with:

19-16 TRENCHLESS CONSTRUCTION

## 19-16.01 GENERAL

### 19-16.01A Summary

1

Section 19-16 includes general specifications for installing culvert or pipeline using trenchless method.

### 19-16.01B Definitions

2

**bore:** Borehole excavated using trenchless construction for the installation of culvert or pipeline.

3

**faulting:** The difference in elevation between surface of adjacent concrete pavement slabs across a transverse joint determined using the FHWA ProVAL automated faulting measurements module.

4

**overcut:** Radial annular gap between bore and outer pipe wall.

### 19-16.01C Submittals

#### 19-16.01C(1) General

5

Submittal that includes land survey items must be stamped and signed by a land surveyor who is registered as a land surveyor in the State, or a person licensed to practice land surveying in the State.

### 19-16.01C(2) Contractor Qualifications

6

Submit:

1. Summary of the contractor's experience that demonstrates compliance with section 19-16.01D(3)

2. List of at least 5 projects completed in past 5 years that demonstrate the contractor's qualifications and ability to perform the work. For each project includes:

2.1. Project description

2.2. Project owner’s name, email address, and phone number

2.3. Project completion date

#### 19-16.01C(3) Shop Drawings

7

Submit 5 copies of shop drawings. After review, submit 8 copies for authorization and use during construction.

8

Shop drawings must be stamped and signed by an engineer who is registered as a civil engineer in the State.

9

Shop drawings must include:

1. Your name, address, telephone number, and email address

2. Plans showing work site layout, cross sections and profile of construction equipment, shield cut, overcut, pipes, and construction operation and sequence

3. Details of automated electronic system for excavation and alignment monitoring that can produce continuous record

4. Details of pipe and pipe joints that can carry and uniformly distribute the thrust of jacking forces, if applicable, and other construction loads in addition to overburden, earth and hydrostatic pressures

#### 19-16.01C(4) Calculations

10

Submit 5 copies of calculations. After review, submit 8 copies for authorization and use during construction.

11

Calculations must be stamped and signed by an engineer who is registered as a civil engineer in the State.

12

Calculations must include:

1. Bracing, shoring, and thrust block design

2. Thrust forces and distribution of the forces for trenchless construction

3. Groundwater and surface water flow, and placement and capacity of the dewatering system

4. Estimated ground surface movement profile, and contour on highway pavement and 2 horizontal planes between highway surface and the elevation of trenchless construction.

5. Anticipated quantity of spoils by volume

#### 19-16.01C(5) Work Plans

13

Submit 5 copies of work plans. After review, submit 8 copies for authorization and use during construction.

14

Work plans must be stamped and signed by an engineer who is registered as a civil engineer in the State.

15

Work plans must include:

1. Your name, address, telephone number, and email address

2. Description of the trenchless construction method, sequence of operations, type of excavated face support, and spoil removal

3. Manufacturer and type of construction equipment for excavation, boring, spoil removal, lubrication, jacking, and grouting, related operating system proposed, and capability of equipment chosen

4. Additional subsurface exploration, including locations, drilling or sounding methods, and testing methods

5. Dewatering system, and plan to divert, control, and dispose of surface water and groundwater

6. Plans to reduce movement to be less than the maximum values under sections 19-16.01D(5)(c) and 19-16.01D(5)(d)

7. Contingency plan for: failed excavated face, damaged pipe, excessive ground surface or subsurface movement, deviation of alignment exceeding tolerance, and flooding

8. Methods for inspecting and grouting voids immediately outside of the completed culvert or pipeline

9. Mitigation Plan for restoring the pavement and ground surface

#### 19-16.01C(6) Monitoring Plans

16

Submit monitoring plans for:

1. Culvert or pipeline grade and alignment control, including monitoring instruments, layout of instrumentation points, construction details, and monitoring frequency

2. Logging of excavated materials, including anticipated volume of excavation and measured volume of removed spoil

3. Critical operations of applicable trenchless construction, including excavation, boring, spoil removal, lubrication, jacking, installation, and grouting

4. Ground surface movement for highway section with Annual Average Daily Traffic (AADT) volume:

4.1. Greater than or equal to 100,000 Include digital surface survey method, survey data processing and analysis method, and digital surface file.

4.2. Less than 100,000 Include survey method, and survey points shown.

5. Subsurface movement, including monitoring instruments and equipment, layout of monitoring alignment, method, and frequency of monitoring

6. Pavement smoothness monitoring, including monitoring instruments and equipment, method, and frequency of monitoring, report templates

#### 19-16.01C(7) Culvert or Pipeline Control Line Survey

17

Submit control line survey. Control line may be on a local coordinate system if the control is referenced to the project coordinate system.

#### 19-16.01C(8) Daily Construction Record

18

Submit daily construction record before noon the day after the completion of each work shift.

19

Daily construction record must include:

1. Date and time of operation.

2. Names of key personnel.

3. Length of constructed culvert or pipeline, including coordinates and elevation of the beginning and ending (latitude, longitude and northing, easting, elevation) of the culvert or pipeline advanced during each work shift. Record must reference the project coordinate system designated by the Department.

4. Rate of advance.

5. Jacking force.

6. Problems encountered, possible causes, and mitigation performed.

7. Geological log of excavated face and materials, with the logging performed by a geologist who is registered as an engineering geologist in the State.

8. Records and field note of:

8.1. Any visible cracks.

8.2. Culvert or pipeline line and grade control.

8.3. Anticipated and actual volumes of spoil removed and causes of the volume discrepancy.

8.4. Groundwater table elevation if dewatering is required.

#### 19-16.01C(9) Ground Surface Movement Monitoring Records

20

For highway section with AADT volume is equal to or greater than 100,000, submit:

1. Before construction:

1.1. Survey data

1.2. Surface model

1.3. Comparison between your and the Department’s surface model demonstrating compliance with the Department’s Survey Manual and supplemental guidance

2. During and after construction:

2.1. Survey data

2.2. Surface model

2.3. Vertical movement based on the comparison between current and preconstruction surface model

21

For highway section with AADT volume is less than 100,000, submit:

1. Before construction:

1.1. Survey data

1.2. Comparison between your and the Department’s survey demonstrating your survey’s compliance with the quality requirements

2. During and after construction:

2.1. Survey data

2.2. Vertical movement based on the comparison of current and the Department’s preconstruction surface data

#### 19-16.01C(10) Subsurface Movement Monitoring Records

22

If subsurface movement monitoring is required under section 19-16.01D(5)(c), submit:

1. Before construction:

1.1. Calibration and verification report of the monitoring system

1.2. Baseline reading

2. Monitoring records during and after construction

#### 19-16.01C(11) Pavement Smoothness Report

23

If pavement smoothness monitoring is required under section 19-16.01D(5)(d), submit:

1. Inertial profiler certification under section 36-3.01D(2)

2. Pavement smoothness reports in the following schedule:

2.1. Pre-construction report before work starts

2.2. Monthly report by the 5th day of each month during construction

2.3. Post-construction report after trenchless construction and pavement restoration are completed

24

Pavement smoothness report must include:

1. Inertial profile data with the values of 5 inertial profiler runs for each lane and average values for each lane. The begin and end positions of each inertial profile must be within 1.0 foot of the monitored section.

2. ALR.

3. Faulting at each concrete pavement joint.

25

Inertial profiler data must comply with section 36-3.01C(2).

ALR values of each inertial profile of the monitored section must be presented as a spreadsheet that includes:

1. Current and previously recorded values

2. Calculated change from pre-construction value to the nearest whole percentage.

3. Values increased by more than

3.1. 10 percent must be highlighted in yellow

3.2. 20 percent must be highlighted in orange

4. Values greater than 180 inches/mile must be highlighted in red.

26

Faulting at each concrete pavement joint must be presented as a spreadsheet that includes:

1. Current and previously recorded values

2. Values greater than 0.75 inches must be highlighted in red.

3. Profile with the number of faulting greater than 0.1 inches increased by more than

3.1. 10 percent must be highlighted in yellow

3.2. 20 percent must be highlighted in red

#### 19-16.01C(12) Contact Grouting Record

27

Submit contact grouting record before noon the day after the completion of each work shift.

28

Contact grouting record must include:

1. Injection locations

2. Grout quantity

3. Grout pressure

4. Measurements and observations, including heave, casing or carrier pipe movement, grout loss quantity, communication between grout ports, ground surface, and nearby utilities and storm drains

5. Problems encountered, possible causes, and mitigation performed

#### 19-16.01C(13) Post-Construction Record

29

Submit a copy of the completed culvert or pipeline construction inspection records, including video recording and photographs.

30

Submit as-built plans showing details and alignment of the constructed culvert or pipeline, horizontal and elevation survey based on project coordinate system, any problems encountered, and mitigation actions performed.

31

Submit as-built plans showing details of pavement restoration work performed.

### 19-16.01D Quality Assurance

#### 19-16.01D(1) General

32

Not Used

#### 19-16.01D(2) Pre-construction Meeting

33

Hold a pre-construction meeting at least 10 days before the start of culvert or pipeline construction. The Engineer conducts the meeting.

34

Attendees must include:

1. The Engineer

2. Your project manager

3. Your project superintendent

4. The subcontractor for trenchless construction

35

Provide and present:

1. Culvert or pipeline construction shop drawings, work plans, and calculations

2. Mitigation plans for both during and after construction

3. Construction timeline and critical path activities

#### 19-16.01D(3) Contractor Qualifications

36

The contractor for trenchless construction of culvert or pipeline must:

1. Have successfully completed at least 5 projects in the past 5 years involving trenchless construction of culvert or pipeline in similar lengths and diameters in similar geotechnical conditions

2. Employ a superintendent, who has successfully completed at least 5 of such projects

#### 19-16.01D(4) Quality Control

37

Not Used

#### 19-16.01D(5) Department Acceptance

##### 19-16.01D(5)(a) General

38

Not Used

##### 19-16.01D(5)(b) Ground Surface Movement Monitoring

39. District Design, Land Surveys, and Utilities should identify on the Plans the critical above ground structures and utilities near the culvert or pipeline alignment that need to be monitored and the locations of the instruments to be placed. The locations should be accessible.

###### 19-16.01D(5)(b)(i) General

Mark monitoring points on critical structures and utilities at locations shown. Include these points in monitoring surveys. Perform monitoring surveys before noon and at ambient temperature below 85 degrees F.

40

Perform ground surface survey under the Department’s Survey Manual and supplemental guidance.

41

Notify the Engineer at least 15 days before trenchless construction for the Department to perform a pre-construction ground surface survey.

###### 19-16.01D(5)(b)(ii) Highway section with AADT volume equal to or greater than 100,000

42

The Department will provide:

1. Control points for ground surface movement monitoring.

2. Pre-construction digital surface model. The model will be based on a grid of points spaced not more than 1-foot apart and will extend 50 feet in each direction from the culvert or pipeline centerline.

43

Use the provided control points for ground surface movement monitoring. Use the provided surface model to determine the movement of ground surface and embankment slope.

44

Before starting trenchless construction, perform baseline ground surface survey.

45

Perform ground surface movement monitoring survey

1. Weekly during construction

2. Biweekly for 1 month after completion of each installation

46

Produce the surface model based on the monitoring survey data and calculate the movement of monitoring points using pre-construction surface model. Each monitoring survey may have different grid points. Digital survey file must be in Civil 3D or Land XML format.

47

Each ground surface horizontal and vertical measurement must be accurate to ± 0.03 feet on pavement and ± 0.1 feet on unpaved surfaces at the 95 percent confidence level. Vertical movement produced by comparing current surface model with pre-construction surface model must be accurate to ± 0.01 feet on pavement and ± 0.1 feet on unpaved surfaces at the 95 percent confidence level.

48

If ground surface movement in the pavement above the advancing pipe meets the requirements for 2 consecutive weeks, you may reduce the frequency of monitoring survey to biweekly.

49

Notify the Engineer at completion of each installation. The Department will perform ground surface survey 1 month after completion of each installation.

50

Ground surface vertical movement must comply with the following requirements:

|  |  |
| --- | --- |
| Ground Surface Vertical Movement | |
| Quality characteristic | Requirement |
| Critical Structure Monitoring Points – Horizontal or Vertical (max, feet) | 0.02 |
| Highway surface (max, feet) | 0.04 |
| Embankment slope (max, feet) | 0.2 |

51

If ground surface vertical movement requirements are not met:

1. Immediately stop work

2. Notify the Engineer

3. Submit an alternative construction method

4. Submit a mitigation plan that includes methods to fill the voids created under the ground surface and restore the density of subsurface materials

5. Monitor ground surface movement in the area above the advancing pipe:

5.1. Daily until no additional vertical movement is detected in the areas that exceed the movement requirements

5.2. Every two days until the vertical movement meets the requirements for 2 consecutive weeks

###### 19-16.01D(5)(b)(iii) Highway section with AADT volume less than 100,000

52

The Department will provide pre-construction survey as the baseline survey.

53

Use the provided baseline survey for ground surface movement monitoring.

54

Before trenchless construction, perform ground surface survey under the Department’s Survey Manual and supplemental guidance.

55

Establish monitoring points to be surveyed:

1. At critical structures as shown

2. In a grid extending 20 feet on each side of the culvert or pipeline centerline, including embankment slopes, and spaced at:

2.1. 5 feet along culvert or pipeline centerline

2.2. 10 feet along the roadway centerline

56

Perform ground surface movement monitoring survey

1. Daily during construction

2. Biweekly for 1 month after completion of each installation

57

Notify the Engineer immediately of any discrepancies.

58

Ground surface survey and vertical movement produced by comparing the current survey with pre-construction survey must be accurate to ± 0.03 feet on pavement and ± 0.1 feet on unpaved surfaces at the 95 percent confidence level.

59

Notify the Engineer at completion of each installation. The Department will perform ground surface survey 1 month after completion of each installation.

60

Ground surface vertical movement must comply with the following requirements:

|  |  |
| --- | --- |
| Ground Surface Vertical Movement | |
| Quality characteristic | Requirement |
| Critical Structure Monitoring Points – Horizontal or Vertical (max, feet) | 0.06 |
| Highway surface (max, feet) | 0.06 |
| Embankment slope (max, feet) | 0.2 |

61

If ground surface vertical movement requirements are not met:

1. Immediately stop work

2. Notify the Engineer

3. Submit an alternative construction method

4. Submit a mitigation plan that includes methods to fill the voids created under the ground surface and restore the density of subsurface materials

5. Monitor ground surface movement in the area above the advancing pipe twice each work shift until no additional vertical movement is detected in the areas that exceed the movement requirements

##### 19-16.01D(5)(c) Subsurface Movement Monitoring

62

Subsurface movement monitoring is required if:

1. Bore diameter is greater than 48 inches

2. Minimum vertical distance between pavement surface and top of culvert is less than 8 times the bore diameter

63

Install horizontal in-place inclinometers with MEMS to monitor subsurface movement at:

1. 6 feet above the crown and along the center line of the culvert or pipeline

2. 6 feet above the crown and 5 feet away horizontally from the spring lines of the culvert or pipeline.

64. District Design, Land Surveys, and Utilities should work with utility companies to identify on the Plans the critical underground utilities near the culvert or pipeline alignment that need to be monitored and the locations of the instruments to be placed. The instruments described in this section may be installed near the utilities when needed. But consider the cost.

Install movement monitoring instruments for critical underground utilities at locations shown.

65

Before trenchless construction, calibrate instruments and monitoring system. Produce calibration and verification report. Take readings at least 3 times to establish pre-construction baseline readings that is accurate to ± 0.01 inches.

66

Perform subsurface movement monitoring

1. Twice daily during construction

2. Twice weekly for 1 month after completion of each installation

67

Subsurface movement must comply with the following requirement:

|  |  |
| --- | --- |
| Subsurface Movement | |
| Quality characteristic | Requirement |
| Subsurface movement (max, inches) | 0.2 |

68

If subsurface movement requirement is not met:

1. Immediately stop work

2. Notify the Engineer

3. Submit an alternative construction method

4. Submit a mitigation plan that includes methods to fill the voids created under the ground surface and restore the density of subsurface materials

##### 19-16.01D(5)(d) Pavement Smoothness Monitoring

69

Pavement smoothness monitoring is required if:

1. AADT volume of the section of highway above the culvert or pipeline is greater than 100,000

2. Minimum vertical distance between pavement surface and the top of bore is less than 8 times the bore diameter

70

Perform inertial profiler verification tests under section 36-3.01D(3)(b)(ii).

71

Perform preconstruction, monthly during construction, and postconstruction pavement smoothness monitoring using inertial profiler.

72

Perform pavement smoothness monitoring under section 36-3.

73

Establish control points that can trigger the begin and end positions of each profile run for each lane. The control points must be located at least 0.1 miles from the culvert or pipeline center line measured along the highway center line. The same control points must be used throughout the construction period.

74

Perform 5 inertial profile runs of each traffic lane between the begin and end control points. The distance measuring instrument (DMI) direction of increase and the DMI station used to record the begin control point must be the same in all profiles of the lane.

75

For concrete pavement, faulting must be determined using ProVAL Automated Faulting module, with:

1. Nominal Joint Spacing set to the average slab length

2. Segment Length set to 528 feet

3. Joint Window set to 2 feet

4. Joint Detection Method set to “Step”

5. Cracks unchecked

76

Pavement smoothness of both asphalt concrete and concrete pavements based on the average ALR of 5 inertial profiles of the monitored section for each lane must meet the following requirements:

1. If preconstruction average ALR is equal to or less than 180 inches/mile, the final average ALR must not increase by more than 20 percent due to construction, with the maximum allowable ALR of 180 inches/mile.

2. If preconstruction average ALR is greater than 180 inches/mile, the final average ALR must not increase by more than 5 inches/mile compared to pre-construction values.

77

Pavement smoothness of concrete pavement must meet the following additional requirements:

1. If preconstruction average faulting is equal to or less than 0.75 inches, the final average faulting must not increase by more than 0.25 inches due to construction, with the maximum allowable faulting of 0.75 inches

2. If preconstruction average faulting is greater than 0.75 inches, the final average faulting must not increase by more than 0.10 inches compared to pre-construction values

3. Number of faulting with value greater than 0.1 inches must not increase by more than 20 percent due to construction

78

If pavement smoothness requirements are not met:

1. Immediately stop work

2. Notify the Engineer

3. Submit an alternative construction method

4. Submit a mitigation plan that includes methods to fill the voids created under the ground surface and restore the density of subsurface materials

5. Monitor pavement smoothness in the area above the advancing pipe:

5.1. Weekly until pavement smoothness stops decreasing

5.2. Biweekly until pavement smoothness meets the requirements for 2 consecutive measurements

##### 19-16.01D(5)(e) Culvert or Pipeline Line, Grade, and Shape

79

For each culvert or pipeline:

1. Survey and record control lines at least 7 days before starting trenchless construction

2. Observe and adjust measurements of survey control lines weekly. Report discrepancies to the Engineer.

80

Survey and record the centerline of the constructed culvert or pipeline after each section is advanced, or every 5 feet of advancement, whichever is shorter.

81

Line and grade of a culvert or pipeline centerline must meet the following requirements throughout the entire culvert or pipeline alignment:

|  |  |
| --- | --- |
| Line and Grade | |
| Quality characteristic | Requirement |
| Line deviation (max, inches) | 6 |
| Grade deviation (max, inches) | 1 |

82

The completed culvert or pipeline must have the shape and dimensions shown throughout the length of the culvert or pipeline. The flow line must be in the direction shown.

## 19-16.02 MATERIALS

### 19-16.02A General

83. The pipe inside diameter may be revised to a size that can be entered to perform contact grouting considering the pipeline length.

For pipe with inside diameter greater than or equal to 24 and less than 48 inches and contact grouting is to be performed from inside of the pipe, the pipe sections must have prefabricated grout ports at 12 o’clock circumferential position every 6 feet along the pipe.

84

For pipe with inside diameter of 48 inches or larger, the pipe sections must have prefabricated grout ports at 2, 4, 8, and 10 o'clock circumferential positions every 6 feet along the pipe.

## 19-16.03 CONSTRUCTION

### 19-16.03A General

85

The superintendent must be present at the job site while work is in progress.

86

Perform trenchless excavation and install culvert or pipeline to the line and grade shown. When excavation or installation is out of line or grade, make immediate alignment correction.

87

Protect existing structures, pavement, and utilities. Restore and repair immediately any damage resulting from construction.

88

Repair or replace any damaged pipe sections.

### 19-16.03B Excavation

89

Overcut must be less than

1. 1 inch or 5 percent of the culvert or pipeline outside radius, whichever is less

2. 2 inches for trenchless construction using horizontal directional drilling method.

90

Notify the Engineer immediately if you encounter obstruction or condition that impedes construction.

### 19-16.03C Contact Grouting

91

After completion of culvert or pipeline installation, inspect annular space for voids. Grout all voids within 48 hours of the completion of pipe installation.

92. The inside diameter may be revised to a size that can be entered to perform contact grouting considering the pipe length.

The hidden text instruction in section 71-3.03 limits contact grouting to pipes greater than 60 inches in diameter and human entry must be possible. This instruction will render the need to grout from the ground surface for pipes with diameter between 24 inches and 60 inches. To perform grouting from ground surface will require traffic control and yield unknown result of the grouting.

Perform grouting:

1. From the ground surface for culvert or pipeline with inside diameter less than 24 inches

2. Through pipe grout ports if inside diameter is 24 inches or greater under section 71-3.03

93

Grout for contact grouting must comply with section 71-3.01B(2).

94

Grout pump's pressure measured at the point of injection must comply with section 71-3.01A(4)(c)(ii).

### 19-16.03D Restore Highway Pavement

95

After completion of trenchless construction of culvert or pipeline, restore highway pavement to meet the requirements in section 19-16.01D(5). Restore asphalt concrete pavement with mill and fill. Repair or replace concrete pavement with dowels for any cracks and spalling caused by construction.

## 19-16.04 PAYMENT

96

Not Used