



**TABLE 1**  
**STANDARD SPECIFICATIONS REFERENCED IN REPORT**

<b>DOCUMENT</b>	<b>TITLE</b>
OPSS 501	Construction Specification for Compacting
OPSS 539	Construction Specification for Temporary Protection Systems
SP 105S10	Construction Specification for Compaction
SP 105S19	Construction Specification for Protection Systems
SP 206S03	Construction Specification for Grading
SP 405F03	Construction Specification for Pipe Subdrains
SP 903S01	Construction Specification for Piling
OPSD-200.010	Earth/Shale Grading – Undivided Rural
OPSD-203.030	Embankments Over Swamp - Existing Slopes Maintained
OPSD-3000.100	Foundation Piles – Steel H-Pile Driving Shoe
OPSD-3090.100	Foundation Frost Depth for Northern Ontario
OPSD-3101.150	Minimum Granular Backfill Requirements - Walls Abutment



**TABLE 2**  
**GRADATION SPECIFICATION FOR SAND FILL IN**  
**PRE-AUGERED HOLES AT INTEGRAL ABUTMENTS**

<b>MTO Sieve Designation</b>	<b>Percentage Passing by Mass</b>
2 mm (#10)	100
600 $\mu$ m (#30)	80 – 100
425 $\mu$ m (#40)	40 – 80
250 $\mu$ m (#60)	5 – 25
150 $\mu$ m (#100)	0 – 6

Note: From MTO Report S0-96-01, Revision 1 – July, 1996.



## **APPENDIX A**

### Recommended Procedures for Pile Driving Monitoring NSSP



### **Recommended Procedures for Pile Driving Monitoring NSSP**

The following items should be included in the pile driving monitoring survey:

1. Both ends of the existing bridge bents should be surveyed to check for loss of level pivoting at one of the ends of the bents.
2. The survey should be carried out every 15 minutes while driving the piles in the group that is adjacent to the existing timber piles remaining in place (in the case where half of the bridge is being removed); after the new piles are driven past 20 m depth, the survey frequency may be changed to every 30 minutes.
- 2A. The time intervals for the survey reading should be adjusted in the field to reflect the speed of the pile penetration. At least two readings should be obtained above 15 m depth for each pile.
3. The survey should be carried out three times a day for the other piles.
4. The survey should continue daily for 1 month after the pile driving is finished and weekly for an additional 3 months.
5. The alert limits of the movements measured for the existing bridge bents should be provided by the structural designer.
6. The locations and placement of the survey points should be submitted to the designer for approval.

Since the new piles are to be driven to refusal, it is anticipated that this survey will not be required when the second half of the bridge will be constructed.



## **APPENDIX B**

### Results of Slope Stability Analyses

## RESULTS OF SLOPE STABILITY ANALYSES

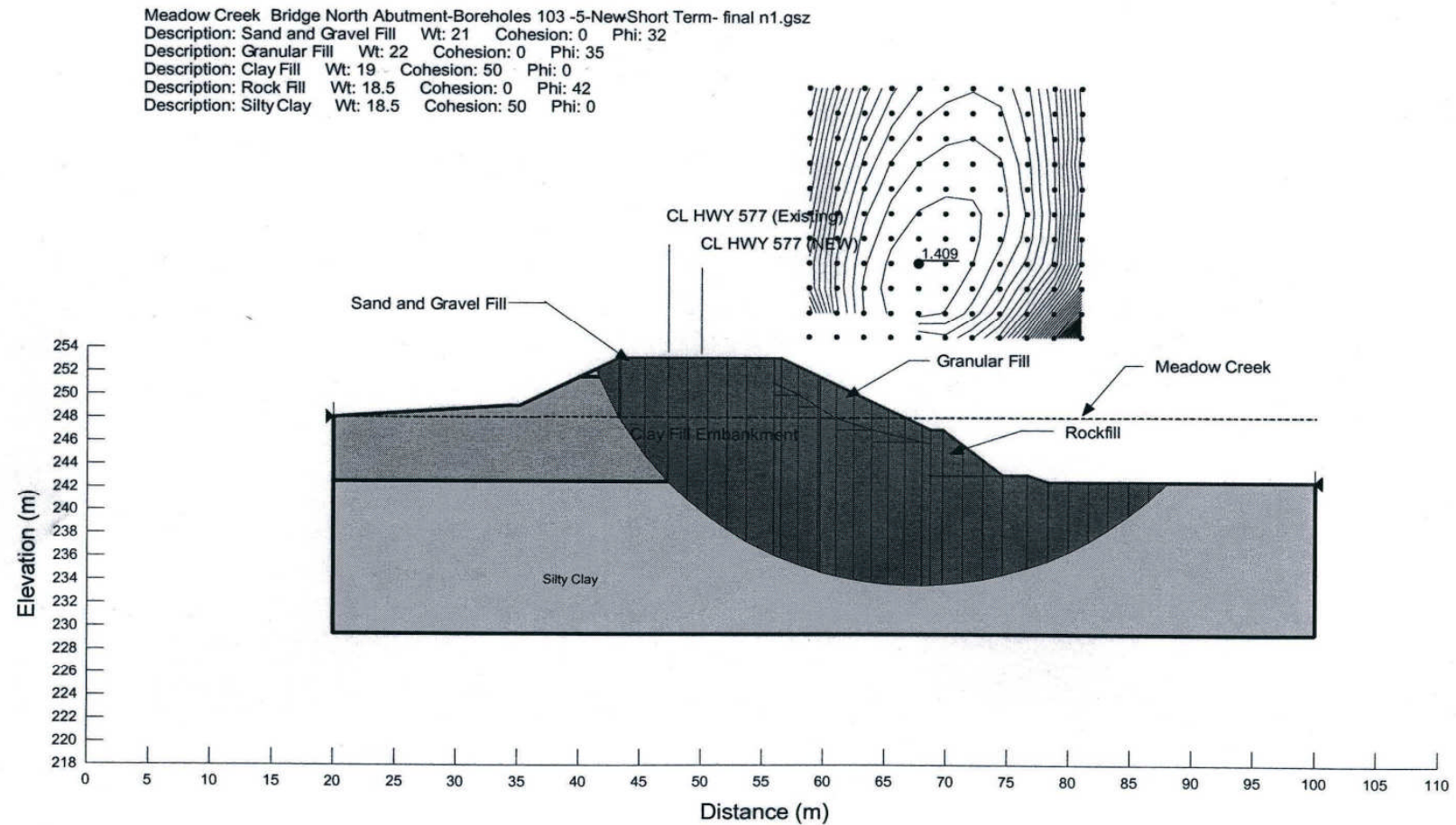


FIGURE 1

## RESULTS OF SLOPE STABILITY ANALYSES

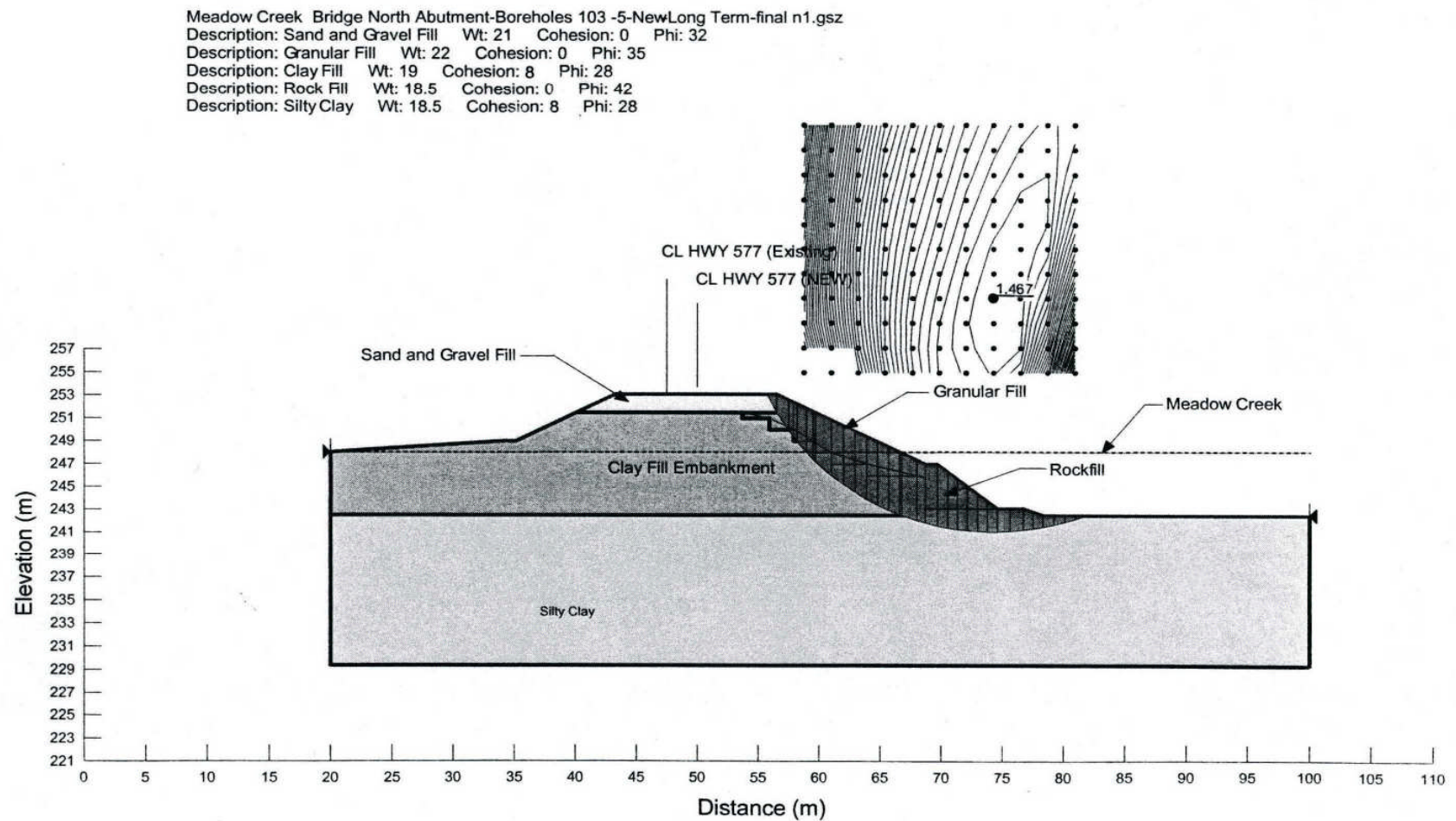
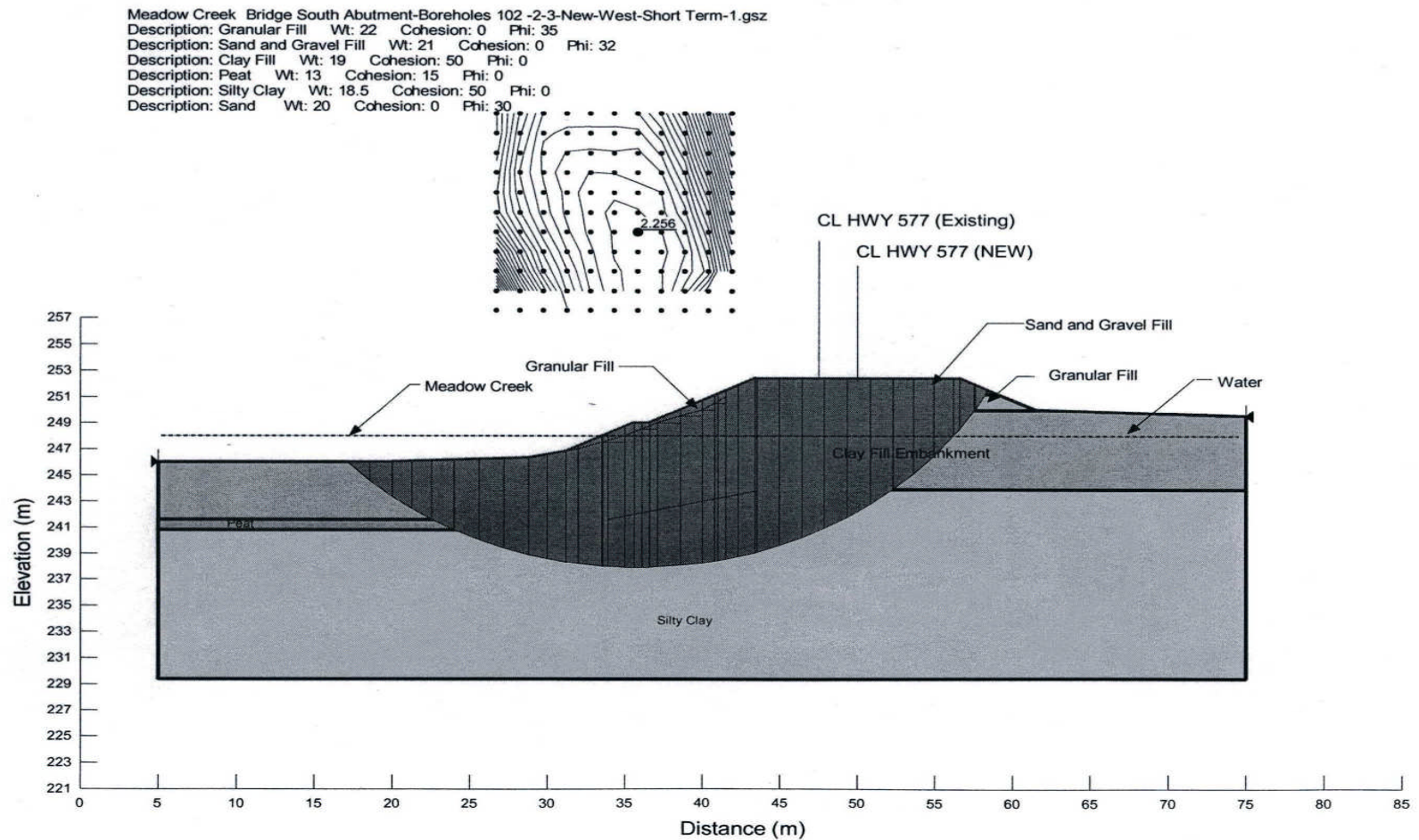


FIGURE 2

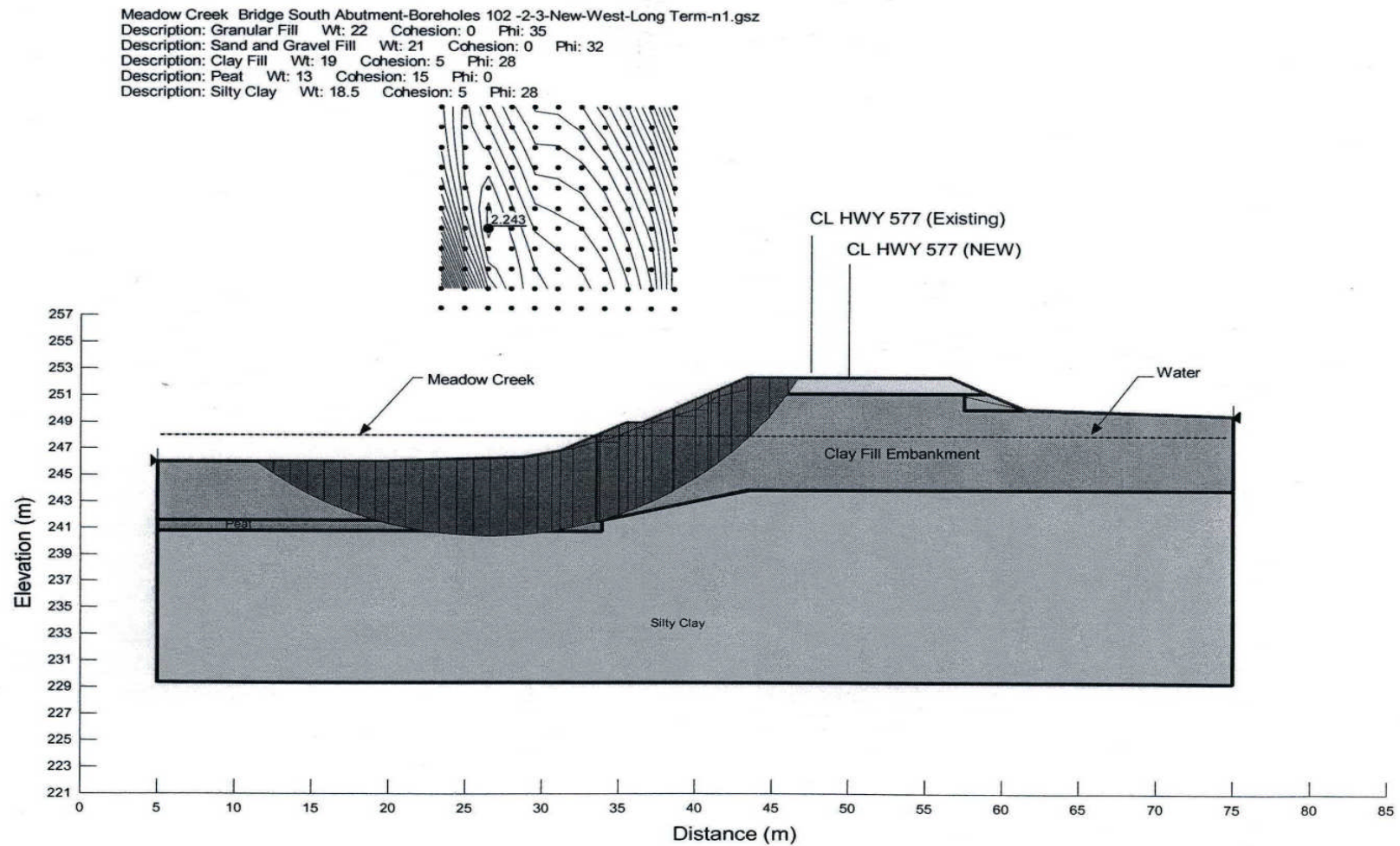
## RESULTS OF SLOPE STABILITY ANALYSES



**FIGURE 3**



## RESULTS OF SLOPE STABILITY ANALYSES



**FIGURE 4**



## **APPENDIX C**

### Embankment Settlement Monitoring Program

## **SUPPLY AND INSTALLATION OF EMBANKMENT MONITORING EQUIPMENT**

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### **Special Provision**

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#### **1.0 SCOPE**

This special provision covers the requirements for the supply and installation of the following geotechnical instruments:

- Standpipe Piezometers (SPP)
- Settlement Plates (SP)
- Surface Movement Markers (SMM)

The purpose of these instruments is to monitor the porewater pressure and settlement in the foundation soils under the new embankment widenings and to monitor ground movements along the top of the existing embankments. The data will be used for the planning and construction of the final approach embankments at the site. Porewater pressures are measured inside of the standpipe piezometers. Settlement and ground movements are measured by surveying with total station equipment at the top of the settlement rods and surface movement markers.

#### **2.0 DEFINITIONS**

For the purposes of this special provision the following definitions apply:

**Foundations Engineering Consultant:** means a Foundations Engineering Consulting firm registered in the MTO consultant acquisition system (RAQS) with specialty rating 'Geotechnical (Structures and Embankments) - Medium Complexity'. The Geotechnical Consultant shall not be the same consultant that has been retained by the Contract Administrator.

**Geotechnical Engineer:** means a Geotechnical Engineer employed by the Foundations Engineering Consultant and having experience and expertise to provide design and inspection services to the Contractor for installation of the geotechnical instruments.

#### **3.0 SUBMISSION AND DESIGN REQUIREMENTS**

##### **3.1 Working Drawings**

All submissions shall bear the seal and signature of the Geotechnical Engineer.

The Contractor shall submit details of proposed installations, including:

- Design and construction drawings, including equipment layout;
- Installation methodology and timing;
- Equipment and material specifications, data sheets;
- Location and types of survey benchmarks; and
- Installation schedule.

Submissions shall be made to the Contract Administrator a minimum of 15 days before the start of instrument installation.

### 3.2 Subsurface Conditions

A Foundation Investigation Report that describes the subsurface conditions at the instrumentation locations is available, as specified in the Contract. The Owner warrants that the information provided in the report can be relied upon with the following exceptions:

1. Any interpretations of data or opinions expressed in the report are not warranted; and
2. Although the raw measured data presented is warranted, the Contractor must satisfy himself as to the sufficiency of the information presented and obtain any updating or additional information, and perform any studies, analysis or investigations the Contractor deems necessary in order to prepare his design, at no additional cost to the Owner.

### 3.3 Certificate of Conformance

Upon completion of installation for each type of equipment, the Contractor shall submit to the Contract Administrator a Certificate of Conformance sealed and signed by the Geotechnical Engineer stating that the materials and work have been supplied and installed in general conformance with the working drawings and Contract documents.

## 4.0 MATERIALS

### 4.1 Equipment Operation and Weather Conditions

All installation and monitoring equipment and associated materials shall be capable of withstanding the range of temperatures possible for their location within the ground or on the surface. The instruments shall be capable of operating within the manufacturer's stated accuracy throughout the temperature range. The contractor is advised that the equipment shall remain in place at the completion of the contract and should be accessible for continued monitoring.

### 4.2 Instrumentation Requirements

A summary of instrumentation requirements is given in Table 1. Details and specific material requirements for each type of equipment are presented elsewhere in this special provision.

Table 1 - Instrument Quantities and Locations

INSTRUMENT I.D.	STATION	OFFSET FROM CENTRELINE	NO. OF INSTRUMENTS		
			SPP	SP	SMM
South Approach Embankment					
SMM1	19+837	5.0 m Lt	–	–	1
SMM2, SPP1	19+837	1.0 m Rt	1	–	1
SP1, SPP2	19+837	10.0 m Rt	1	1	–
SMM3	19+847	5.0 m Lt	–	–	1
SMM4, SPP3	19+847	1.0 m Rt	1	–	1
SP2, SPP4	19+847	10.0 m Rt	1	1	–

INSTRUMENT I.D.	STATION	OFFSET FROM CENTRELINE	NO. OF INSTRUMENTS		
			SPP	SP	SMM
North Approach Embankment					
SMM5	19+938	5.0 m Lt	—	—	1
SMM6, SPP5	19+938	1.0 m Rt	1	—	1
SP3, SPP6	19+938	10.0 m Rt	1	1	—
SMM7	19+948	5.0 m Lt	—	—	1
SMM8, SPP7	19+948	1.0 m Rt	1	—	1
SP4, SPP8	19+948	10.0 m Rt	1	1	—
		Total SP	8	4	8

Note: Offsets are approximate and referenced to new Highway 577 centreline. Instruments are to be installed where practical and where approved by the geotechnical engineer.

## **5.0 SETTLEMENT PLATES**

### **5.1 Materials**

#### **5.1.1 Steel Base Plate**

The Contractor shall supply a steel base plate with thickness of at least 6.35 mm. The plate shall be at least 0.5 m by 0.5 m.

#### **5.1.2 Rod**

The Contractor shall supply a steel pipe Schedule 40 with an outside diameter not less than 25.4 mm (1"), supplied in lengths as required to complete the installation as described elsewhere.

The top end of each length of rod shall be threaded to receive a cap. A rounded cap shall be installed at the top of the rod in such a way that a single survey point can be clearly identified and returned to.

#### **5.1.3 Friction Reducing Sleeve**

The Contractor shall supply a friction-reducing sleeve consisting of Schedule 40 - 50.8 mm (2") O.D. PVC pipe cut perpendicular to the axis of the pipe.

#### **5.1.4 Protective Surround**

The Contractor shall supply a protective surround for the portion of the rod within the embankment and surcharge.

The surround shall consist of 300 mm diameter corrugated steel pipe (CSP - OPSS 1801) with the ends cut perpendicular to the axis of the pipe and free of burrs and sharp edges. The space between the CSP and the Friction Reduction Sleeve (PVC pipe) shall be filled with medium to coarse sand.

Prior to the installation of instruments, the Contractor shall accurately survey and stake the location of each instrument and obtain a ground elevation at each instrument location.

### 5.1.5 Surface Movement Markers (SMM)

The Contractor shall supply 38mm x 38mm wood stakes or 20 mm steel rods at least 1.2 m in length.

## 5.2 Construction

### 5.2.1 General

The purpose of the settlement plates is to monitor settlements of the embankment base. Settlement is measured by survey of the top of the rod with reference to stable, non-settling benchmarks.

The purpose of the surface movement markers is to monitor settlements and horizontal movements of the surface of the fill. The vertical and horizontal movements are measured by survey of the top of the markers with reference to stable, non-settling benchmarks.

### 5.2.2 Locations of Settlement Plates and Surface Movement Markers

The locations of the settlement plates are shown in Table 2.

Table 2- Approximate Settlement Plates Locations

INSTRUMENT I.D.	STATION	OFFSET FROM CENTRELINE	ESTIMATED THICKNESS OF NEW FILL (m)	APPROXIMATE INSTALLATION (*)	
				DEPTH (m)	ELEVATION (m)
South Approach Embankment					
SP1	19+837	10.0 m Rt	2.0	4.0	248.5
SP2	19+847	10.0 m Rt	2.0	4.0	248.5
North Approach Embankment					
SP3	19+938	10.0 m Rt	2.0	4.5	248.5
SP4	19+948	10.0 m Rt	2.0	4.5	248.5

(\*) Depth is below new road grade.

The locations of the surface movement markers are shown in Table 3.

Table 3 - Approximate Surface Movement Markers Locations

INSTRUMENT I.D.	STATION	OFFSET FROM CENTRELINE	ESTIMATED THICKNESS OF NEW FILL (m)	APPROXIMATE INSTALLATION (*)	
				DEPTH (m)	ELEVATION (m)
South Approach Embankment					
SMM1	19+837	5.0 m Lt	1.0	1.0	251.5
SMM2	19+837	1.0 m Rt	1.0	1.0	251.5
SMM3	19+847	5.0 m Lt	1.0	1.0	251.5
SMM4	19+847	1.0 m Rt	1.0	1.0	251.5

INSTRUMENT I.D.	STATION	OFFSET FROM CENTRELINE	ESTIMATED THICKNESS OF NEW FILL (m)	APPROXIMATE INSTALLATION (*)	
				DEPTH (m)	ELEVATION (m)
North Approach Embankment					
SMM5	19+938	5.0 m Lt	1.0	1.0	252.0
SMM6	19+938	1.0 m Rt	1.0	1.0	252.0
SMM7	19+948	5.0 m Lt	1.0	1.0	252.0
SMM8	19+948	1.0 m Rt	1.0	1.0	252.0

(\*) Depth is below new road grade.

### 5.2.3 Survey Benchmarks

The Contractor shall provide local, stable and non-settling survey benchmarks. The number and locations of benchmarks shall be such that direct sighting is possible from all settlement plates (SP) to at least one bench mark. Elevations shall be surveyed to an accuracy of  $\pm 2$  mm or better.

Prior to the installation of instruments, the Contractor shall accurately survey and stake the location of each instrument and obtain a ground elevation at each instrument location.

### 5.2.4 Installation

#### 5.2.4.1 Settlement Plates

The Contractor shall install settlement plates as per the Contract drawings.

The settlement plates shall be installed immediately after subgrade preparation is completed but prior to fill placement.

The settlement rods shall be attached to a plate at existing ground level. As embankment and surcharge construction proceeds the rods shall be extended above the new top of embankment and surcharge.

Sleeves around the rods shall be installed to reduce friction and allow uninhibited movement of the rod with the plate.

A protective surround shall be extended with the rods as embankment and surcharge construction proceeds.

The settlement plate shall be installed horizontally on undisturbed native soil, just below the existing ground. The elevation of the base of the plate shall be surveyed before backfilling.

The rod shall be fixed to the centre of the plate and perpendicular to the plate. The coupling of the rods shall be such that all sections have the same axis and no separation or contraction will occur at the couplings.

The friction reducing sleeve shall be over the entire length of the rod that is below ground and within the embankment and surcharge fill except that the cap on top of the settlement rod shall extend 25 mm above the top of the friction sleeve at all times.

The settlement rods shall be extended upwards as the embankment and surcharge are constructed so that the top of the rod is always at least 0.3 m but not more than 2m above the surrounding fill. The CSP, Friction Reducing Sleeve and sand protective surround shall be extended with the rods.

The settlement rod shall be in the centre of the CSP and friction-reducing sleeve.

The annulus between the CSP and the friction-reducing sleeve shall be filled with sand to a level not higher than the top of the sleeve.

The elevation, easting and northing of the centre of the base of the plate shall be surveyed.

The elevation, easting and northing of the top of the rod shall be surveyed.

The total distance from the base of the plate to the top of the rod shall be measured to an accuracy of  $\pm 2$  mm or better.

The location of any above ground-monitoring fixture shall be made clearly visible to nearby traffic before, during and after embankment and surcharge construction. Marking shall be of sufficient size to be visible from a reversing vehicle and after heavy snowfalls.

Instruments shall be clearly labelled in the field, each instrument having a unique identifier. The labelling shall remain legible for the full duration of operation.

All instruments shall be adequately protected by the Contractor such that they are not damaged during construction. Any instrument damaged by the Contractor's work shall be immediately replaced and re-surveyed at the Contractor's cost.

#### **5.2.4.2 Surface Movement Markers**

The surface movement markers (SMM) shall be placed immediately upon completion of the surcharge fills. The markers shall be driven/placed to at least 1.0 m below grade. All monitoring points shall be painted yellow and clearly labeled. A roofing nail shall be driven flush with the top of each wooden stake (if these are used) to be used as the survey reference point. The SMM units shall be located as shown on the Contract Drawings.

#### **5.2.5 Completion of Installation**

The Contractor shall notify the Contract Administrator no later than 3 days after installing a settlement plate. At this time the Contractor shall also supply the following information to the Contract Administrator:

- Elevation of plate and rod;
- Dates of installation;
- Installation notes / sketches; and
- Description of settlement rods, sleeve, plate.



Throughout construction, adjustments to the length of any settlement rod shall be coordinated with the Contract Administrator to allow surveying by others of the elevation of the top of the rod immediately before and immediately after adjustment. This surveying is necessary to accurately track the settlement data.

The Contractor shall record and report relevant installation details to the Contract Administrator. These include, but are not limited to:

- Settlement rod easting, northing;
- Elevation of the plate and the top of the rod;
- Distance between base of plate and top of rod;
- Dates of installation;
- Installation notes / sketches.

### **5.2.6 Monitoring**

Monitoring of the settlement plates and surface movement markers will be performed by the Contract Administrator. Monitoring will be conducted throughout the duration of the Contract, including, the embankment and surcharge construction and shall continue after completion of the contract, at the discretion of the MTO contract administrator. The Contractor shall provide installation information as specified above and provide access to the settlement rods for monitoring including, but not limited to a scaffolding platform and ladder if required and snow clearing in the winter for the duration of the contract. The contractor shall provide electric power and general area lighting as needed for reading the instruments.

## **6.0 STANDPIPE PIEZOMETERS**

### **6.1 Materials**

#### **6.1.1 Pipe and Couplings**

The Contractor shall supply Schedule 40 flush jointed - 19mm (3/4") PVC pipe (e.g. 75x5R or 75x10R - Canadian Pipe Supply Ltd.).

#### **6.1.2 Perforated Section**

The Contractor shall supply one 1.5 m long slotted Schedule 40 flush jointed - 19mm (3/4") PVC slotted pipe (e.g. 75x5S Slot 10 Sch 40 - F/J - PVC - Canadian Pipe Supply Ltd.) for each SSP.

#### **6.1.3 Bottom Cap**

The Contractor shall supply bottom caps Schedule 40 flush jointed - 19mm (3/4") PVC (e.g. 448-007FJ - Canadian Pipe Supply Ltd.) to fit the perforated section.

#### **6.1.4 Top Caps**

The Contractor shall supply vented top caps Schedule 40 - 19mm (3/4") PVC (e.g. 448-007FJ-perforated - Canadian Pipe Supply Ltd.) to fit the pipe.

### 6.1.5 Filter Sand

The Contractor shall supply clean washed sand for backfilling around perforated section. The sand shall be Sakrete washed general purpose sand - or equal.

### 6.1.6 Bentonite

The Contractor shall supply bentonite (OPSS 1205) in pellet form for backfilling above the filter sand.

### 6.1.7 Grout

The Contractor shall supply cement-bentonite grout for general backfilling. A suitable grout mix design consists of 23 kg of bentonite (OPSS 1205), 143 litres of water and 40 kg of cement (Type 10 - OPSS 1301).

### 6.1.8 Protective Housing and Surround

The Contractor shall supply a protective housing consisting of 100 mm minimum diameter galvanized steel pipe with a locking cap.

Where the piezometer will be within the embankment or fill provide a protective surround similar to the settlement rod installation.

## 6.2 Construction

### 6.2.1 General

The purpose of the standpipe is to monitor the level of the near surface groundwater table.

### 6.2.2 Location of Standpipes

The locations of the standpipes are given in Table 4.

Table 4 - Standpipe Locations

INSTRUMENT I.D.	STATION	OFFSET FROM CENTRELINE	ESTIMATED THICKNESS OF NEW FILL (m)	APPROXIMATE INSTALLATION (*)	
				DEPTH (m)	ELEVATION (m)
South Approach Embankment					
SPP1	19+837	1.0 m Rt	1.0	9.0	243.5
SPP2	19+837	10.0 m Rt	2.0	9.0	243.5
SPP3	19+847	1.0 m Rt	1.0	6.0	246.5
SPP4	19+847	10.0 m Rt	2.0	7.5	245.0

INSTRUMENT I.D.	STATION	OFFSET FROM CENTRELINE	ESTIMATED THICKNESS OF NEW FILL (m)	APPROXIMATE INSTALLATION (*)	
				DEPTH (m)	ELEVATION (m)
North Approach Embankment					
SPP5	19+938	1.0 m Rt	1.0	7.0	246.0
SPP6	19+938	10.0 m Rt	2.0	9.0	244.0
SPP7	19+948	1.0 m Rt	1.0	11.0	242.0
SPP8	19+948	10.0 m Rt	2.0	11.0	242.0

(\*) Depth is below new road grade. Levels are to be taken at centre of perforated pipe section.

### 6.2.3 Installation

The standpipes shall be installed prior to embankment construction.

Prior to the installation of instruments, the Contractor shall accurately survey and stake the location of each instrument and obtain a ground elevation at each instrument location.

Standpipes will be installed in vertical boreholes.

The Contractor shall make a basic stratigraphic log of boreholes as they are being drilled. In-situ or laboratory testing is not required. Borehole drilling shall be conducted by a recognized drilling subcontractor with eligibility defined by the current MTO Boring Contractor supply list. Boreholes shall be advanced using conventional drilling methods and shall be as straight and vertical as practical.

Installation of the standpipe shall be as per the Contract drawings.

The riser pipe shall be extended upwards as the embankment or preload fill are constructed so that the top of the pipe is always at least 0.3 m but not more than 1.5 m above the surrounding fill.

### 6.2.4 Completion of Installation

The Contractor shall notify the Contract Administrator no later than 3 days after installing a standpipe. At this time the Contractor shall also supply the following information to the Contract Administrator:

- Standpipe location, easting, northing;
- Elevation of ground level;
- Stratigraphic log of subsurface conditions at the standpipe;
- Dates of installation;
- Depth of pipe, stick up;
- Installation notes / backfilling notes.

### **6.2.5 Monitoring**

Monitoring of the standpipe piezometers will be performed by the Contract Administrator. Monitoring will be conducted during the embankment and surcharge construction. The Contractor shall provide installation information as specified above and provide access to the standpipe for monitoring including, but not necessarily limited to snow clearing in the winter. The contractor shall provide electric power and general area lighting as needed for reading the instruments.

### **6.2.6 Decommissioning**

The piezometer installations should be removed after completion of the pre-loading and the holes decommissioned in accordance with the MOE Regulations 903.

## **7.0 BASIS OF PAYMENT**

Payment at the Lump Sum price for this tender item shall be full compensation for all labour, equipment and material to do the work.