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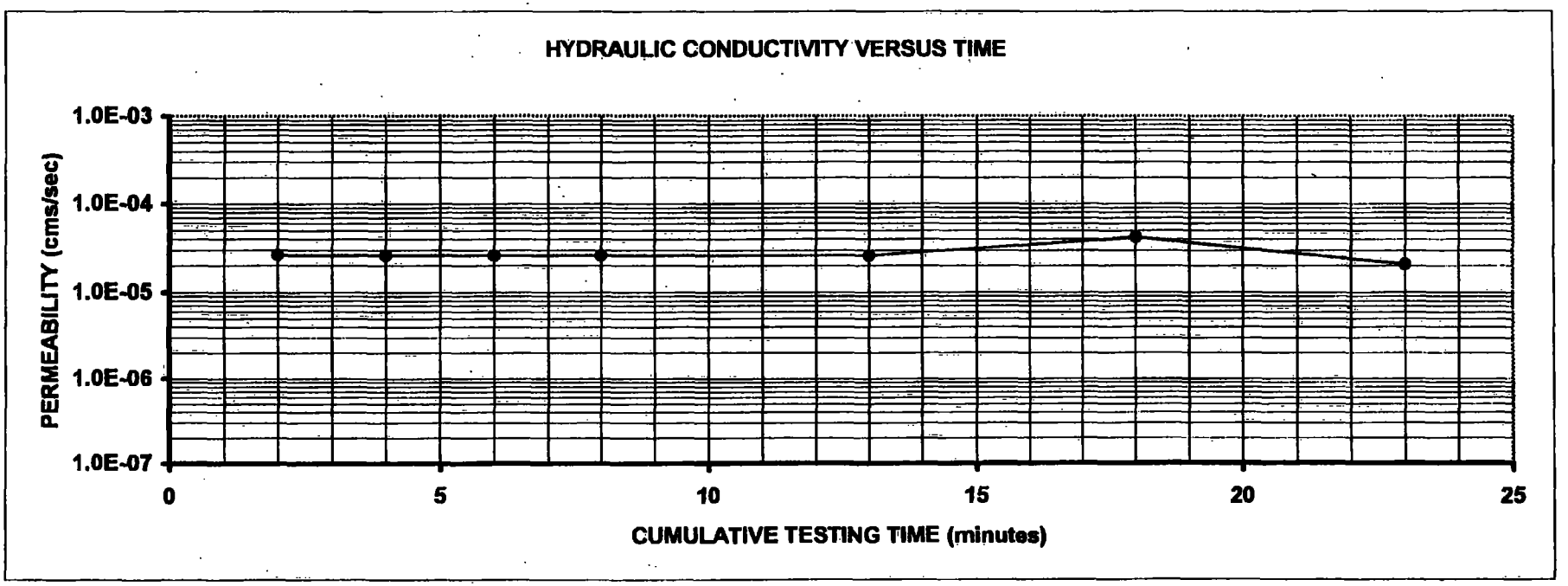
# HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER, ASTM D-5084

**Client:** ENSR Corporation **Project Number:** 051312T
**Project:** Testing Services, AK Steel Soil Analysis, Middletown, Ohio **Date:** 3/1/2006
**Boring Number:** MW3S **Sample Number:** **Depth (ft.):** 25.5-26.0 **Sample Condition:** Undisturbed
**Sample Description:** Gray fine to coarse moist dense SAND and fine gravel, trace silt, clay

| Sample Data Before/After Test | Before | After |
|---|---|---|
| Height (in.) | 4.967 | 4.967 |
| Diameter (in.) | 1.414 | 1.414 |
| Water Content (%) | 8.9 | 8.8 |
| Dry Unit Weight (pcf) | 141.5 | 141.5 |

| Hydraulic Conductivity Data | |
|---|---|
| Type of Permeant Liquid | Water |
| Total Back Pressure (psi) | 1 |
| Maximum Effective Consolidation Stress (psi) | 68 |
| Minimum Effective Consolidation Stress (psi) | 69 |
| Sample Hydraulic Conductivity (cms/sec) | 2.8E-05 |



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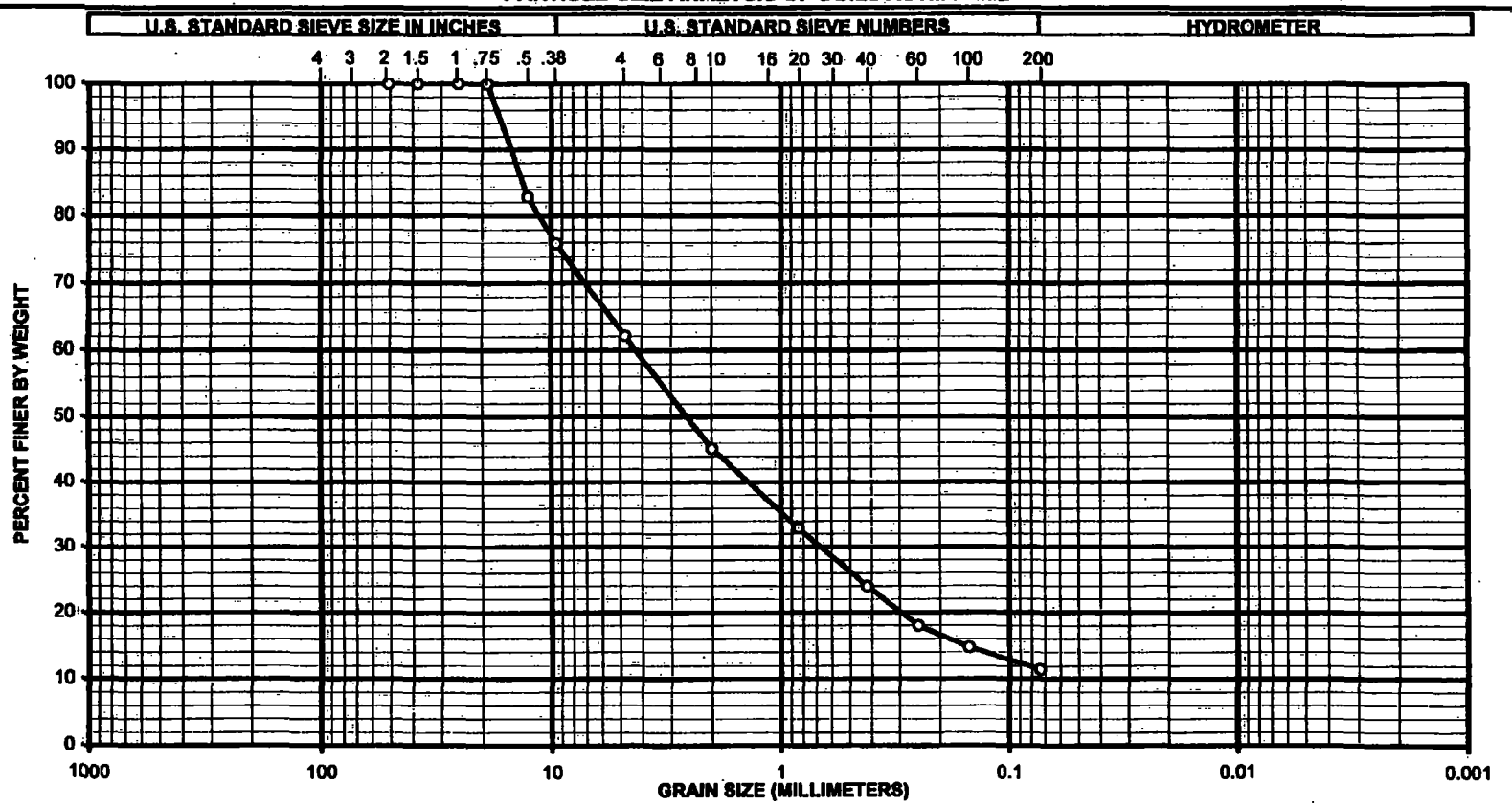
## PARTICLE-SIZE ANALYSIS OF SOILS ASTM D-422




| BOULDER | COBBLE | GRAVEL | | SAND | | | SILT | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | | |

| Boring No. | Sample No. | Elev. or Depth | Description | Nat. w% | LL | PL | PI | | |
|---|---|---|---|---|---|---|---|---|---|
| MW3S | | 25.5' - 26.0' | Gray fine to coarse moist dense SAND and fine gravel, trace silt, clay | 8.9 | | | | Client : | ENSR Corporation |
| | | | | | | | | Project : | Testing Services |
| | | | | | | | | | AK Steel Soil Analysis |
| Gravel (%) | Sand (%) | Silt & Clay (%) | | | | | | | Middletown, Ohio |
| 37.9 | 50.7 | 11.4 | | | | | | Project No.: | 051312T |
| Specification | | | | | | | | Date : | 3/5/2006 |

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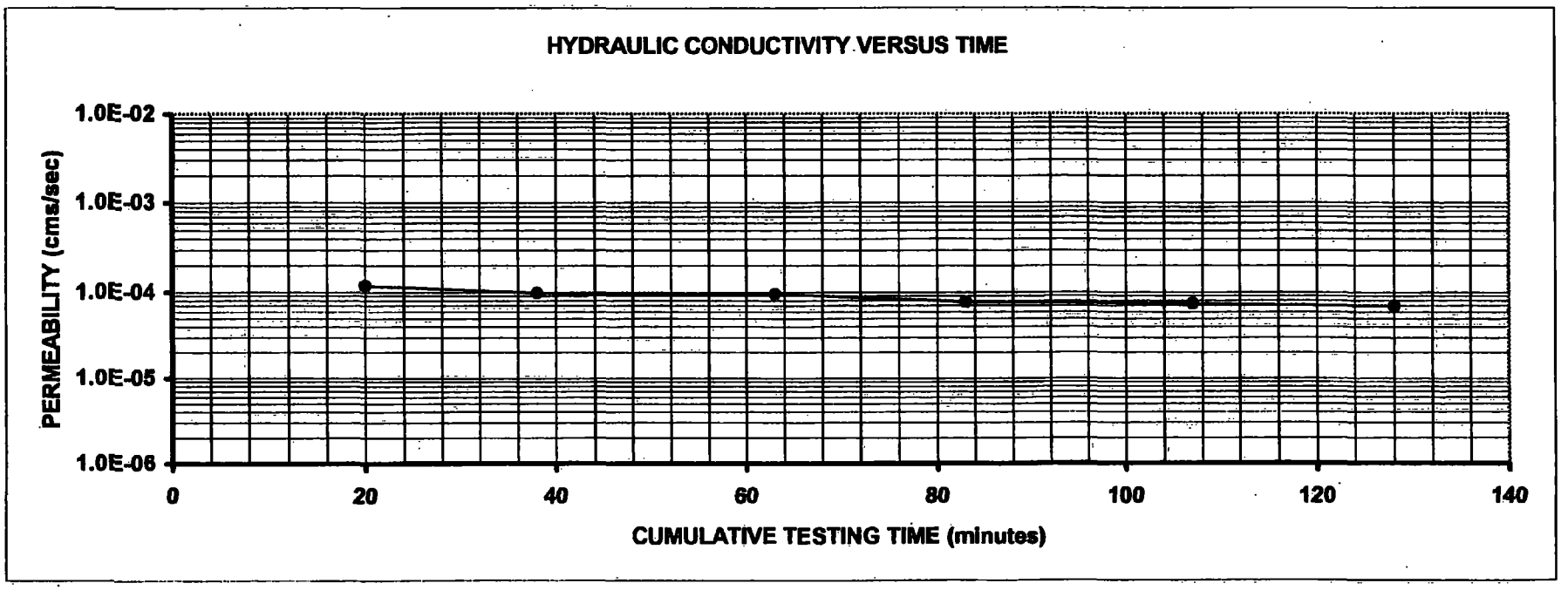
# HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER, ASTM D-5084

**Client:** ENSR Corporation **Project Number:** 051312T
**Project:** Testing Services, AK Steel Soil Analysis, Middletown, Ohio **Date:** 2/6/2006
**Boring Number:** MW3S **Sample Number:** **Depth (ft.):** 27.0-27.5 **Sample Condition:** Undisturbed
**Sample Description:** Brown fine to coarse moist dense SAND and fine gravel, trace silt, clay

| Sample Data Before/After Test | Before | After |
|---|---|---|
| Height (in.) | 4.835 | 4.835 |
| Diameter (in.) | 1.414 | 1.414 |
| Water Content (%) | 6.9 | 9.3 |
| Dry Unit Weight (pcf) | 146.9 | 146.8 |

| Hydraulic Conductivity Data | |
|---|---|
| Type of Permeant Liquid | Water |
| Total Back Pressure (psi) | 1 |
| Maximum Effective Consolidation Stress (psi) | 68 |
| Minimum Effective Consolidation Stress (psi) | 69 |
| Sample Hydraulic Conductivity (cms/sec) | 8.9E-05 |



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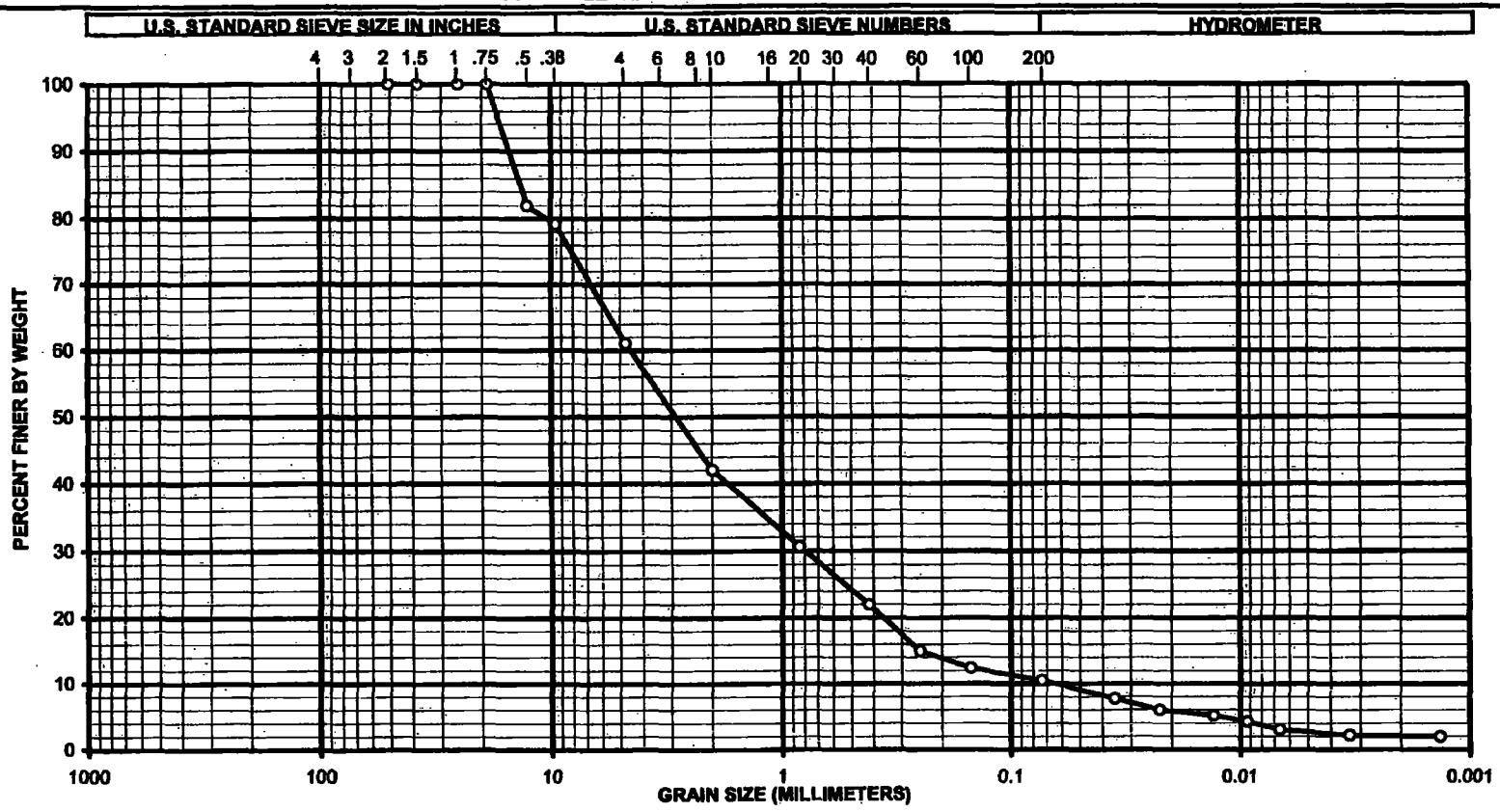
## PARTICLE-SIZE ANALYSIS OF SOILS ASTM D-422




| BOULDER | COBBLE | GRAVEL | | SAND | | | SILT | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | | |

| Boring No. | Sample No. | Elev. or Depth | Description | Nat. w% | LL | PL | PI |
|---|---|---|---|---|---|---|---|
| MW3S | | 27.0' - 27.5' | Brown fine to coarse moist dense SAND and fine gravel, trace silt, clay | 6.9 | | | |

| Gravel (%) | Sand (%) | Silt & Clay (%) | |
|---|---|---|---|
| 38.9 | 50.6 | 7.9 | 2.6 |

Specification

| | |
|---|---|
| Client : | ENSR Corporation |
| Project : | Testing Services |
| | AK Steel Soil Analysis |
| | Middletown, Ohio |
| Project No.: | 051312T |
| Date : | 2/8/2006 |

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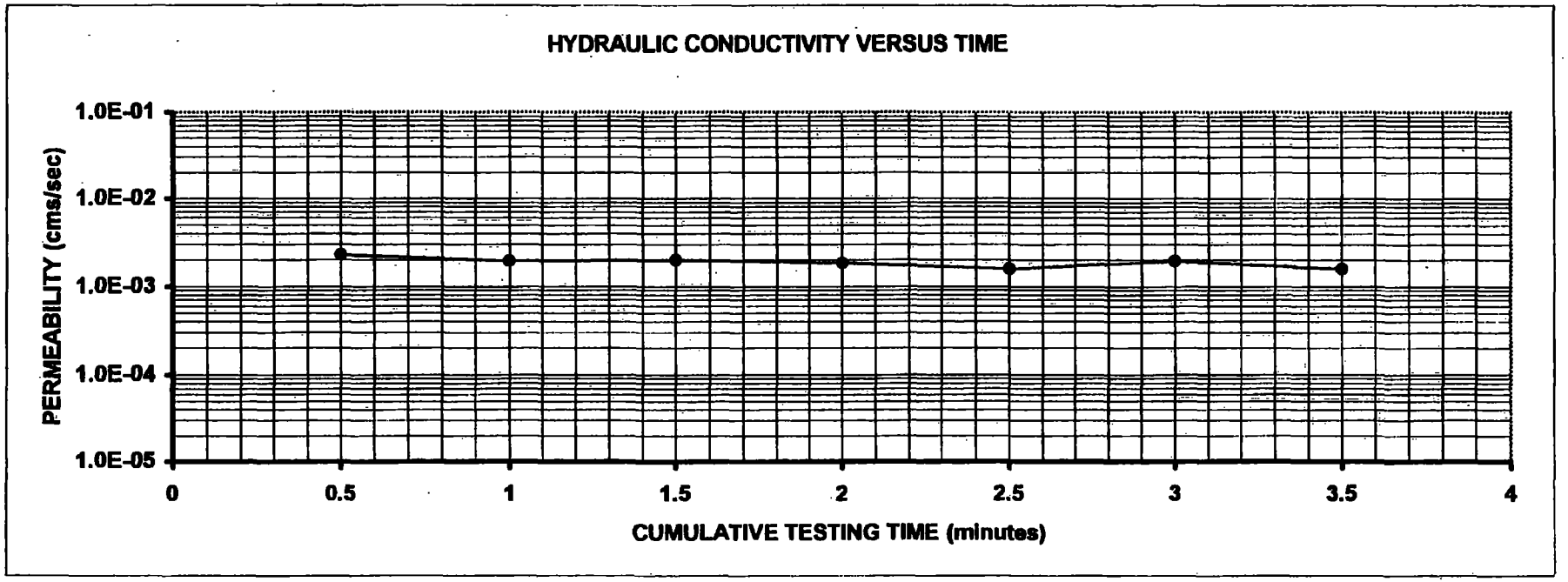
# HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER, ASTM D-5084

**Client:** ENSR Corporation **Project Number:** 051312T
**Project:** Testing Services, AK Steel Soil Analysis, Middletown, Ohio **Date:** 3/1/2006
**Boring Number:** MW3S **Sample Number:** **Depth (ft.):** 27.5-28.0 **Sample Condition:** Undisturbed
**Sample Description:** Brown fine to coarse moist dense SAND, some fine to coarse gravel, trace silt, clay

| Sample Data Before/After Test | Before | After |
|---|---|---|
| Height (in.) | 4.772 | 4.772 |
| Diameter (in.) | 1.402 | 1.402 |
| Water Content (%) | 12.8 | 12.8 |
| Dry Unit Weight (pcf) | 130.7 | 130.7 |

| Hydraulic Conductivity Data | |
|---|---|
| Type of Permeant Liquid | Water |
| Total Back Pressure (psi) | 1 |
| Maximum Effective Consolidation Stress (psi) | 68 |
| Minimum Effective Consolidation Stress (psi) | 69 |
| Sample Hydraulic Conductivity (cms/sec) | 1.9E-03 |



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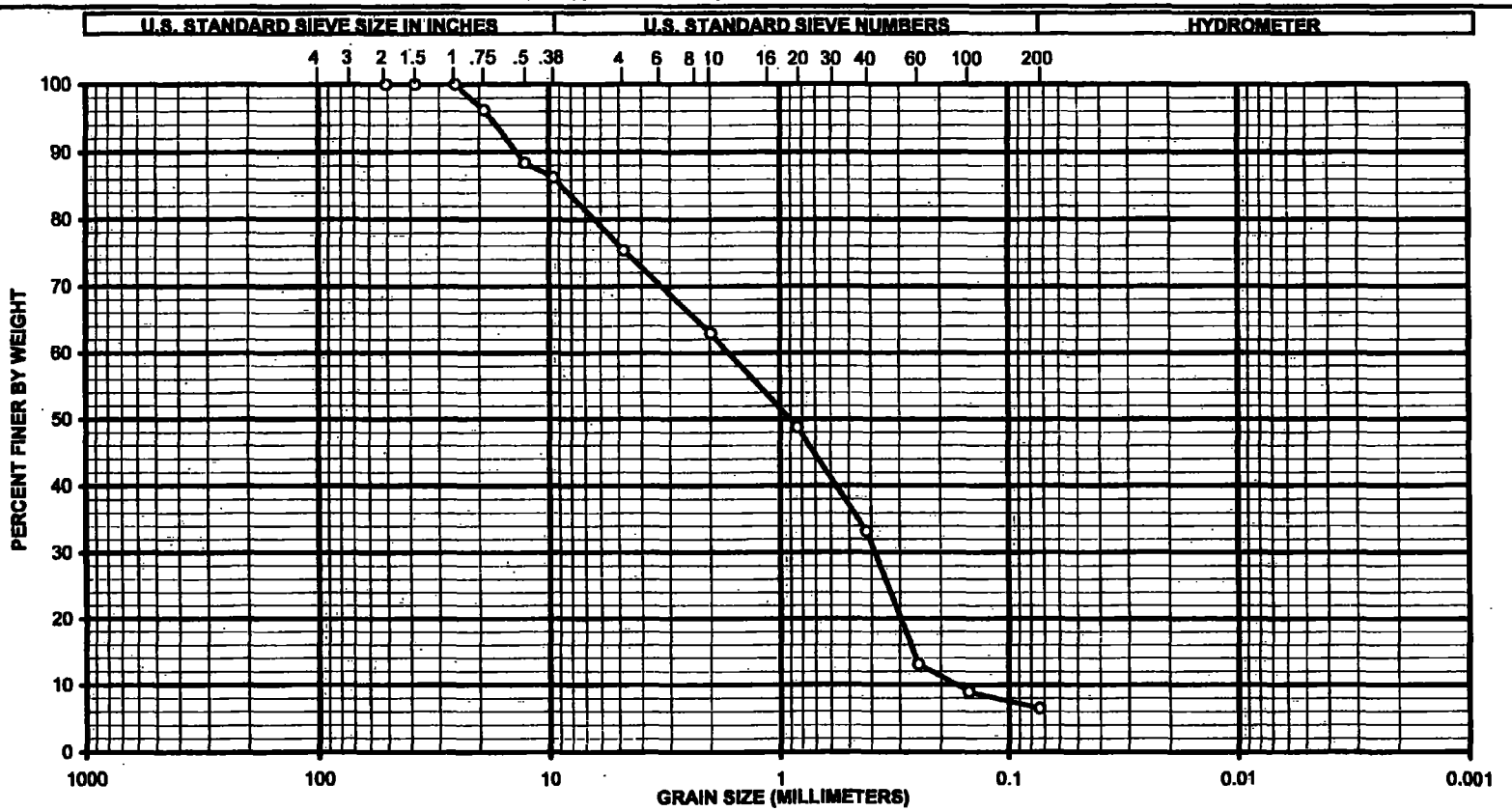
## PARTICLE-SIZE ANALYSIS OF SOILS ASTM D-422




| BOULDER | COBBLE | GRAVEL | | SAND | | | SILT | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | | |

| Boring No. | Sample No. | Elev. or Depth | Description | Nat. w% | LL | PL | PI | | |
|---|---|---|---|---|---|---|---|---|---|
| MW3S | | 27.5' - 28.0' | Brown fine to coarse moist dense SAND, some fine to coarse gravel, trace silt, clay | 12.8 | | | | Client : | ENSR Corporation |
| | | | | | | | | Project : | Testing Services |
| | | | | | | | | | AK Steel Soil Analysis |
| Gravel (%) | Sand (%) | Silt & Clay (%) | | | | | | | Middletown, Ohio |
| 24.6 | 68.9 | 6.5 | | | | | | Project No.: | 051312T |
| Specification | | | | | | | | Date : | 3/5/2006 |

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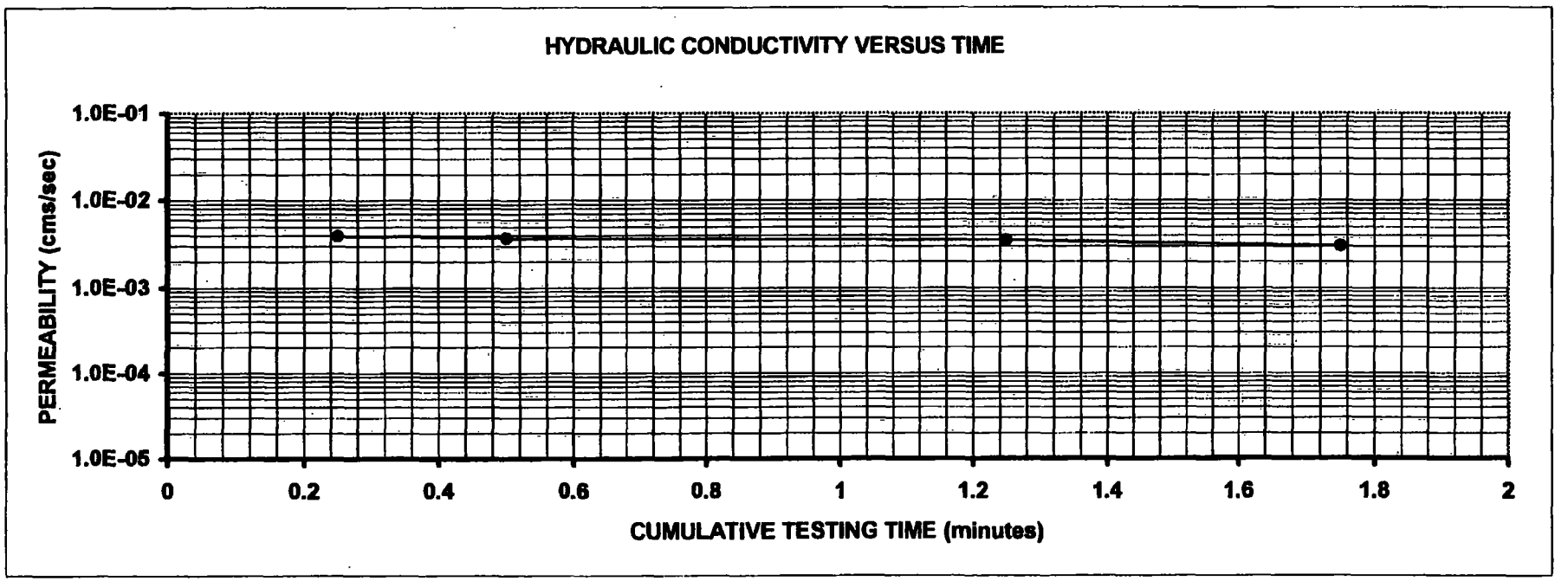
# HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER, ASTM D-5084

**Client:** ENSR Corporation **Project Number:** 051312T
**Project:** Testing Services, AK Steel Soil Analysis, Middletown, Ohio **Date:** 3/7/2006
**Boring Number:** MW6S **Sample Number:** **Depth (ft.):** 27.5-28.0 **Sample Condition:** Undisturbed
**Sample Description:** Brown fine to coarse SAND

| Sample Data Before/After Test | Before | After |
|---|---|---|
| Height (in.) | 3.47 | 3.470 |
| Diameter (in.) | 1.414 | 1.414 |
| Water Content (%) | 12.3 | 15.2 |
| Dry Unit Weight (pcf) | 127.5 | 127.5 |

| Hydraulic Conductivity Data | |
|---|---|
| Type of Permeant Liquid | Water |
| Total Back Pressure (psi) | 1 |
| Maximum Effective Consolidation Stress (psi) | 68 |
| Minimum Effective Consolidation Stress (psi) | 69 |
| Sample Hydraulic Conductivity (cms/sec) | 3.5E-03 |



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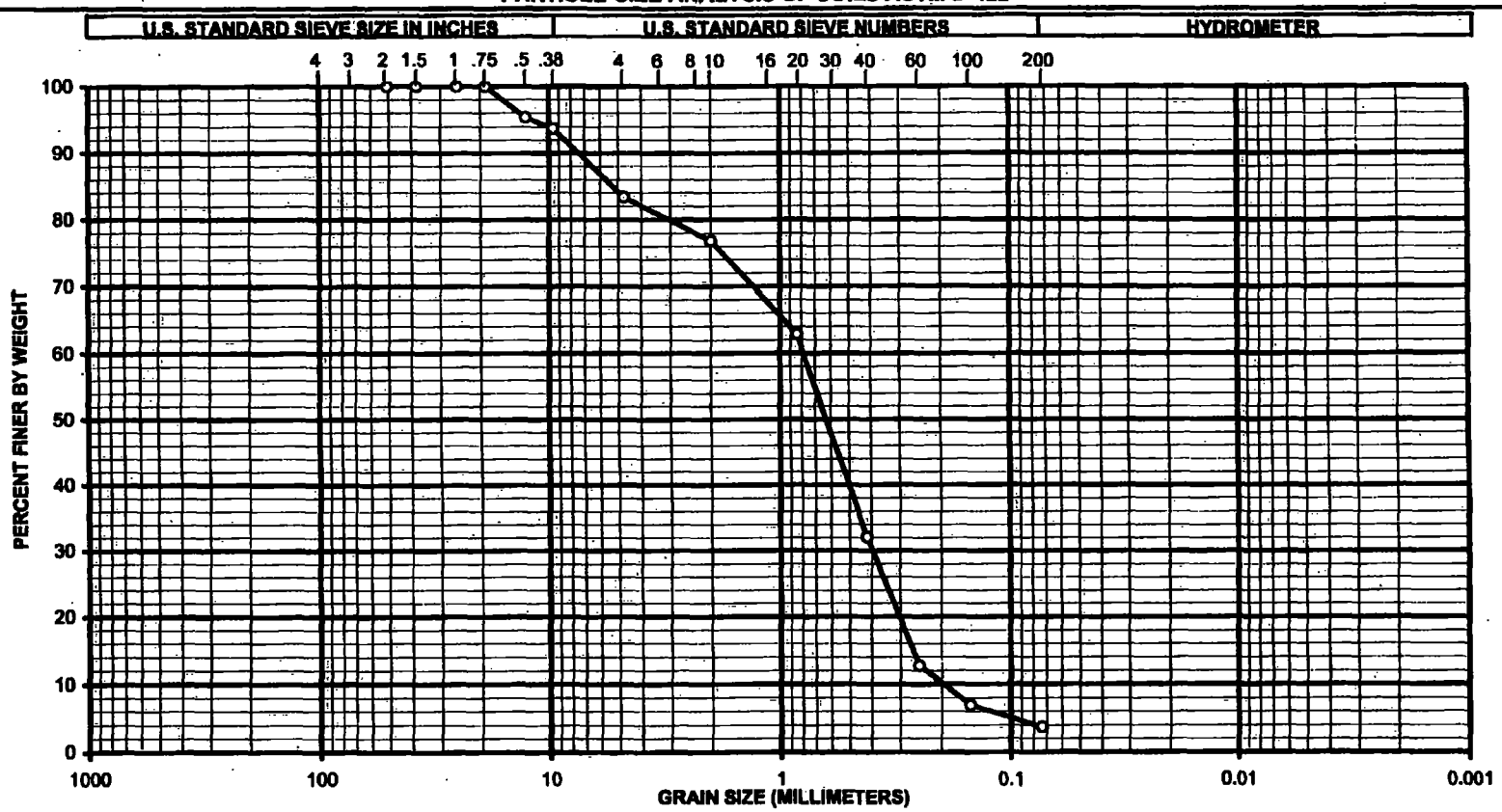
## PARTICLE-SIZE ANALYSIS OF SOILS ASTM D-422




| BOULDER | COBBLE | GRAVEL | | SAND | | | SILT | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | | |

| Boring No. | Sample No. | Elev. or Depth | Description | Nat. w% | LL | PL | PI |
|---|---|---|---|---|---|---|---|
| MW6S | | 28.5' - 29.0' | Brown fine to coarse SAND, little fine gravel, trace silt, clay | 14.3 | | | |
| **Gravel (%)** | **Sand (%)** | **Silt & Clay (%)** | | | | | |
| 16.7 | 79.6 | 3.7 | | | | | |
| **Specification** | | | | | | | |

| | |
|---|---|
| Client : | ENSR Corporation |
| Project : | Testing Services |
| | AK Steel Soil Analysis |
| | Middletown, Ohio |
| Project No.: | 051312T |
| Date : | 3/20/2006 |

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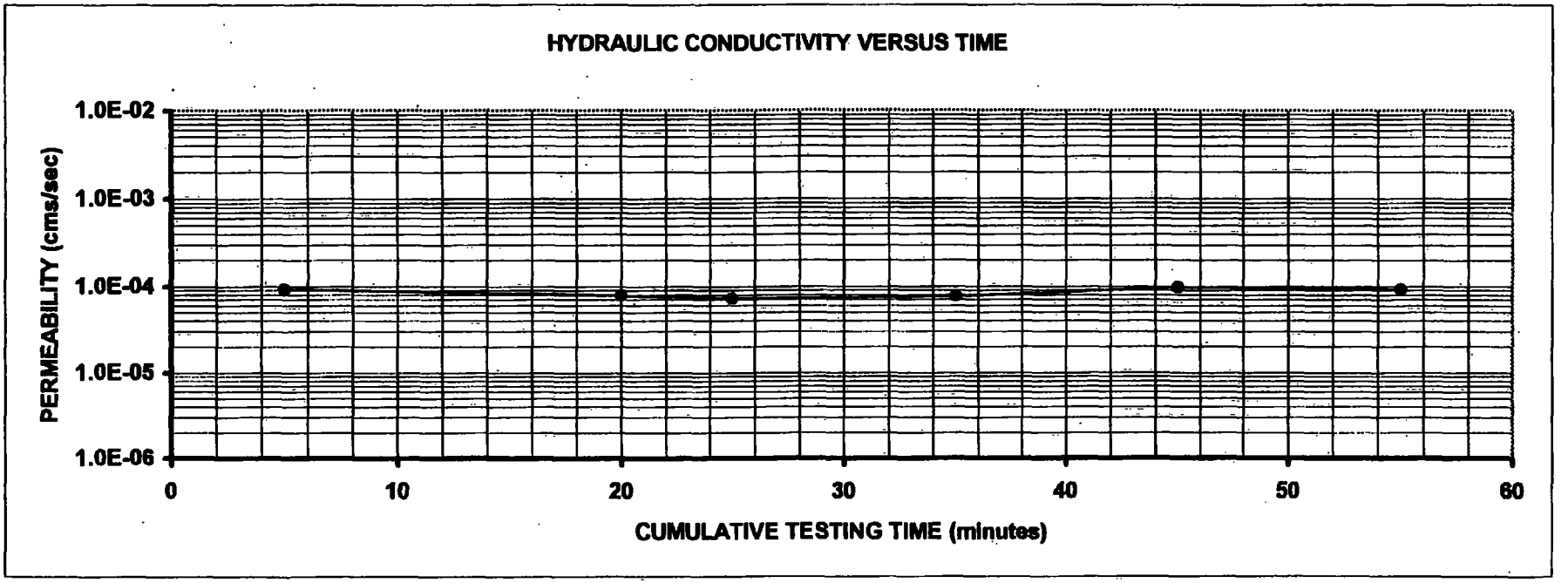
# HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER, ASTM D-5084

**Client:** ENSR Corporation **Project Number:** 051312T
**Project:** Testing Services, AK Steel Soil Analysis, Middletown, Ohio **Date:** 3/7/2006
**Boring Number:** MW6S **Sample Number:** **Depth (ft.):** 29.0-29.5 **Sample Condition:** Undisturbed
**Sample Description:** Brown fine to coarse SAND, little fine gravel, trace silt, clay

| Sample Data Before/After Test | Before | After |
|---|---|---|
| Height (in.) | 4.724 | 4.724 |
| Diameter (in.) | 1.410 | 1.410 |
| Water Content (%) | 10.3 | 11.7 |
| Dry Unit Weight (pcf) | 137.9 | 137.9 |

| Hydraulic Conductivity Data | |
|---|---|
| Type of Permeant Liquid | Water |
| Total Back Pressure (psi) | 1 |
| Maximum Effective Consolidation Stress (psi) | 68 |
| Minimum Effective Consolidation Stress (psi) | 69 |
| Sample Hydraulic Conductivity (cms/sec) | 8.5E-05 |



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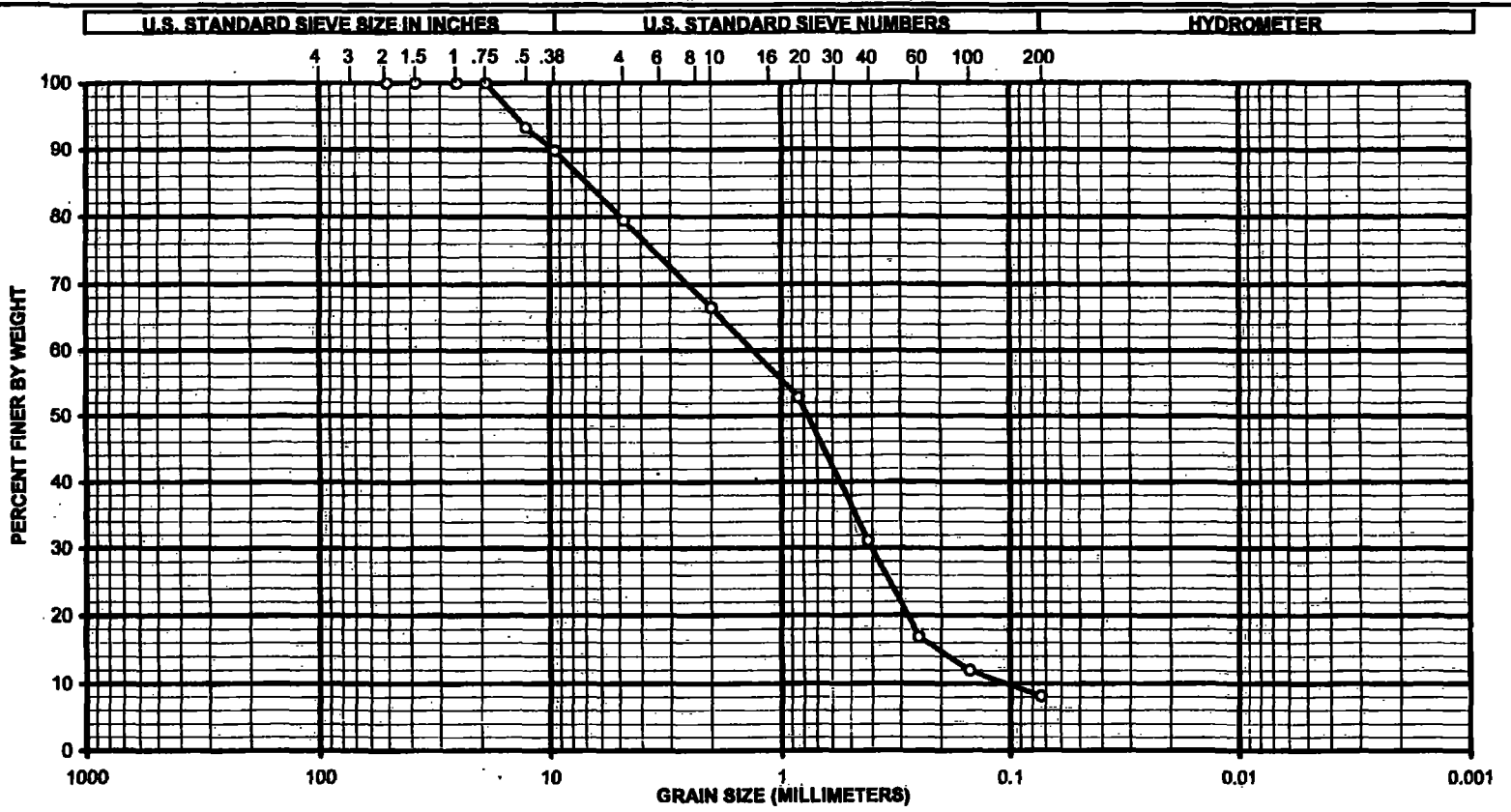
## PARTICLE-SIZE ANALYSIS OF SOILS ASTM D-422




| BOULDER | COBBLE | GRAVEL | | SAND | | | SILT | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | | |

| Boring No. | Sample No. | Elev. or Depth | Description | Nat. w% | LL | PL | PI | | |
|---|---|---|---|---|---|---|---|---|---|
| MW6S | | 29.0' - 29.5' | Brown fine to coarse SAND, little fine gravel, trace silt, clay | 10.3 | | | | Client : | ENSR Corporation |
| | | | | | | | | Project : | Testing Services |
| | | | | | | | | | AK Steel Soil Analysis |
| Gravel (%) | Sand (%) | Silt & Clay (%) | | | | | | | Middletown, Ohio |
| 20.6 | 71.3 | 8.1 | | | | | | Project No.: | 051312T |
| Specification | | | | | | | | Date : | 3/11/2006 |

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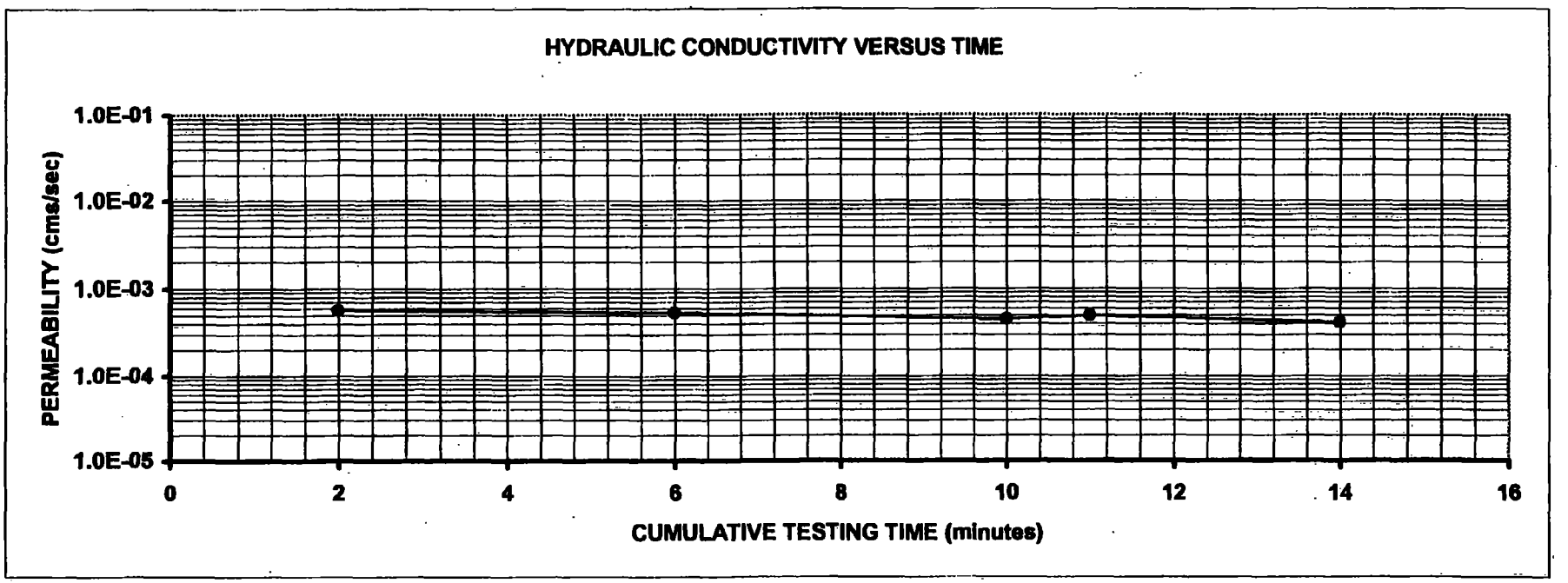
# HYDRAULIC CONDUCTIVITY OF SATURATED POROUS MATERIALS USING A FLEXIBLE WALL PERMEAMETER, ASTM D-5084

**Client:** ENSR Corporation **Project Number:** 051312T
**Project:** Testing Services, AK Steel Soil Analysis, Middletown, Ohio **Date:** 3/7/2006
**Boring Number:** MW6S **Sample Number:** **Depth (ft.):** 29.5-30.0 **Sample Condition:** Undisturbed
**Sample Description:** Brown fine to coarse SAND, trace fine gravel, silt, clay

| Sample Data Before/After Test | Before | After |
|---|---|---|
| Height (in.) | 4.799 | 4.799 |
| Diameter (in.) | 1.407 | 1.407 |
| Water Content (%) | 10.5 | 14.7 |
| Dry Unit Weight (pcf) | 131.1 | 131.1 |

| Hydraulic Conductivity Data | |
|---|---|
| Type of Permeant Liquid | Water |
| Total Back Pressure (psi) | 1 |
| Maximum Effective Consolidation Stress (psi) | 68 |
| Minimum Effective Consolidation Stress (psi) | 69 |
| Sample Hydraulic Conductivity (cms/sec) | 4.9E-04 |



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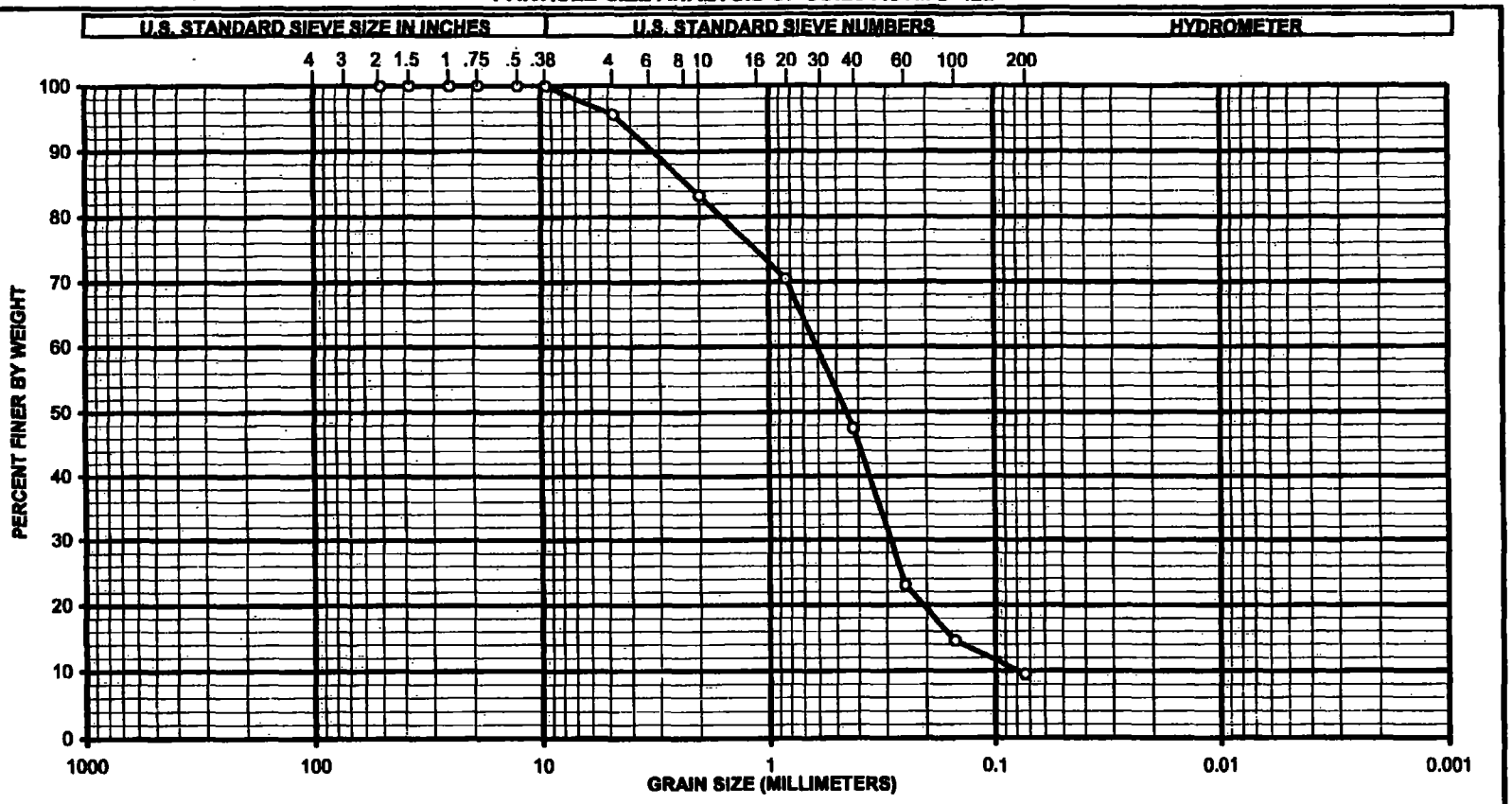
## PARTICLE-SIZE ANALYSIS OF SOILS ASTM D-422




| BOULDER | COBBLE | GRAVEL | | SAND | | | SILT | CLAY |
|---|---|---|---|---|---|---|---|---|
| | | Coarse | Fine | Coarse | Medium | Fine | | |

| Boring No. | Sample No. | Elev. or Depth | Description | Nat. w% | LL | PL | PI |
|---|---|---|---|---|---|---|---|
| MW6S | | 29.5' - 30.0' | Brown fine to coarse SAND, trace fine gravel, silt, clay | 10.5 | | | |
| **Gravel (%)** | **Sand (%)** | **Silt & Clay (%)** | | | | | |
| 4.4 | 86.1 | 9.5 | | | | | |
| **Specification** | | | | | | | |

| | |
|---|---|
| **Client :** | ENSR Corporation |
| **Project :** | Testing Services |
| | AK Steel Soil Analysis |
| | Middletown, Ohio |
| **Project No.:** | 051312T |
| **Date :** | 3/11/2006 |

## TABULATION OF LABORATORY TEST DATA

| BORING NUMBER | DEPTH (ft.) | DESCRIPTION | GRAVEL (%) | SAND (%) | SILT (%) | CLAY (%) | SILT & CLAY (%) | DRY DENSITY (p.c.f.) | WATER CONTENT (%) | HYDRAULIC CONDUCTIVITY (cm./sec.) | POROSITY | ORGANIC MATTER (%) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW19S | 26.0-28.0 | Gray moist stiff sandy SILTY CLAY, trace fine gravel (glacial till) | 7 | 33 | 38 | 22 | -- | 137.1 | 9.7 | $5.2x10^{-7}$ | 0.18 | -- | -- |
| MW11S | 26.0-26.5 | Fine GRAVEL and brown fine to coarse sand, trace silt, clay | 46 | 46 | -- | -- | 8 | 121.1 | 7.1 | $2.1x10^{-5}$ | -- | -- | -- |
| MW11S | 26.5-27.0 | Brown sandy SILTY CLAY, trace fine gravel | 7 | 36 | 41 | 16 | -- | 129.7 | 12.1 | $8.4x10^{-9}$ | 0.26 | -- | -- |
| MW11S | 27.0-27.5 | Brown silty SAND, little clay, trace fine gravel | 8 | 45 | 36 | 11 | -- | 137.9 | 9.5 | $2.0x10^{-8}$ | 0.21 | -- | -- |
| MW11S | 27.5-28.0 | Fine to coarse GRAVEL, some fine to coarse sand, little silt, trace clay | 46 | 29 | 15 | 10 | -- | 134.1 | 7.3 | $3.6x10^{-7}$ | 0.24 | -- | -- |
| MW18S | 38.0-38.5 | Brown fine to coarse SAND, trace fine gravel, silt, clay | 6 | 88 | 4 | 2 | -- | 124.1 | 9.7 | $1.8x10^{-3}$ | 0.27 | -- | -- |
| MW18S | 38.5-39.0 | Brown fine to coarse SAND, some fine gravel, little silt, trace clay | 23 | 63 | 11 | 3 | -- | 141.4 | 10.4 | $1.4x10^{-4}$ | 0.17 | -- | -- |
| AOC2SB2 | 26.0-26.5 | Gray moist hard sandy SILTY CLAY, trace fine gravel (glacial till) | 4 | 32 | 35 | 29 | -- | 136.1 | 7.4 | $1.1x10^{-7}$ | -- | 0.7 | 7.4 |

| BORING NUMBER | DEPTH (ft.) | DESCRIPTION | GRAVEL (%) | SAND (%) | SILT (%) | CLAY (%) | SILT & CLAY (%) | DRY DENSITY (p.c.f.) | WATER CONTENT (%) | HYDRAULIC CONDUCTIVITY (cm./sec.) | POROSITY | ORGANIC MATTER (%) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AOC2SB2 | 26.5-27.0 | Gray moist hard sandy SILTY CLAY, trace fine gravel (glacial till) | 9 | 33 | 33 | 25 | -- | 137.3 | 7.2 | $1.1x10^{-7}$ | -- | 0.8 | 7.5 |
| AOC2SB2 | 27.0-27.5 | Gray moist hard sandy SILTY CLAY, trace fine gravel (glacial till) | 5 | 36 | 34 | 25 | -- | 137.4 | 6.2 | $4.7x10^{-7}$ | -- | 0.6 | -- |
| AOC2SB2 | 27.5-28.0 | Gray moist hard sandy SILTY CLAY, trace fine gravel (glacial till) | 3 | 39 | 35 | 23 | -- | 139.2 | 6.4 | $2.3x10^{-7}$ | -- | 0.8 | 7.5 |
| AOC2SB13 | 36.0-36.5 | Brown moist fine to medium SAND, some silt, little clay, trace fine gravel | 1 | 59 | 23 | 17 | -- | 123.2 | 12.2 | $2.1x10^{-7}$ | -- | -- | -- |
| AOC2SB13 | 36.5-36.7 | Brown fine to coarse SAND, some silt, little clay, trace fine gravel | 7 | 48 | 28 | 17 | -- | 130.7 | 9.2 | $7.9x10^{-6}$ | -- | -- | -- |
| AOC2SB13 | 37.0-37.5 | Gray moist hard sandy SILTY CLAY, trace fine gravel (glacial till) | 4 | 32 | 36 | 28 | -- | 137.5 | 7.1 | $4.3x10^{-7}$ | -- | 0.5 | 7.5 |
| AOC2SB13 | 37.5-38.0 | Gray moist hard sandy SILTY CLAY, trace fine gravel (glacial till) | 3 | 33 | 36 | 28 | -- | 136.2 | 8.5 | $3.1x10^{-7}$ | -- | 0.3 | 7.5 |
| MW14S | 33.0-33.5 | Brown fine to coarse SAND, little fine gravel, trace silt, clay | 11 | 75 | 11 | 3 | -- | 132.7 | 9.6 | $7.5x10^{-4}$ | 0.22 | -- | -- |

| BORING NUMBER | DEPTH (ft.) | DESCRIPTION | GRAVEL (%) | SAND (%) | SILT (%) | CLAY (%) | SILT & CLAY (%) | DRY DENSITY (p.c.f.) | WATER CONTENT (%) | HYDRAULIC CONDUCTIVITY (cm./sec.) | POROSITY | ORGANIC MATTER (%) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW14S | 33.5-34.0 | Brown fine to coarse SAND and coarse to fine gravel, trace silty, clay | 40 | 53 | -- | -- | 7 | 128.3 | 6.8 | -- | 0.26 | -- | -- |
| MW14S | 34.0-34.5 | Brown fine to coarse SAND and fine gravel, trace silt, clay | 39 | 55 | -- | -- | 6 | 130.4 | 13.7 | $3.0x10^{-3}$ | 0.25 | -- | -- |
| MW14S | 34.5-35.0 | Brown fine to coarse SAND, little fine gravel, trace silt, clay | 16 | 78 | -- | -- | 6 | 129.9 | 2.0 | $1.5x10^{-3}$ | 0.24 | -- | -- |
| MW7S | 29.0-29.5 | Gray to reddish brown dry fine to coarse SAND, little fine gravel, trace silt, clay | 18 | 77 | -- | -- | 5 | 134.7 | 1.6 | $4.0x10^{-4}$ | 0.22 | -- | -- |
| MW7S | 29.5-30.0 | Gray moist fine to coarse SAND and fine coarse gravel, trace silt, clay | 39 | 57 | -- | -- | 4 | 148.0 | 5.5 | $1.1x10^{-3}$ | 0.15 | -- | -- |
| MW7S | 30.5-31.0 | Brown moist fine to coarse SAND | 1 | 98 | -- | -- | 1 | -- | -- | -- | -- | -- | -- |
| MW7S | 31.0-31.5 | Gray moist fine to coarse SAND, some fine gravel, trace silt, clay | 27 | 69 | -- | -- | 4 | 142.6 | 6.5 | $6.2x10^{-5}$ | -- | -- | -- |
| MW5S | 23.5-24.0 | Fine to coarse GRAVEL and brown fine to coarse sand, trace silt, clay | 52 | 45 | -- | -- | 3 | 113.0 | 6.4 | $4.5x10^{-3}$ | 0.35 | -- | -- |

| BORING NUMBER | DEPTH (ft.) | DESCRIPTION | GRAVEL (%) | SAND (%) | SILT (%) | CLAY (%) | SILT & CLAY (%) | DRY DENSITY (p.c.f.) | WATER CONTENT (%) | HYDRAULIC CONDUCTIVITY (cm./sec.) | POROSITY | ORGANIC MATTER (%) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW5S | 25.0-25.5 | Fine GRAVEL, some brown fine to coarse sand, trace silt, clay | 66 | 32 | -- | -- | 2 | 133.3 | 9.9 | $3.8x10^{-3}$ | 0.23 | -- | -- |
| MW5S | 25.5-26.0 | Brown fine to coarse SAND and fine to coarse gravel, trace silt, clay | 40 | 52 | -- | -- | 8 | 144.2 | 7.2 | $2.2x10^{-4}$ | 0.18 | -- | -- |
| MW3S | 25.5-26.0 | Gray fine to coarse moist dense SAND and fine gravel, trace silt, clay | 38 | 51 | -- | -- | 11 | 141.5 | 8.9 | $2.8x10^{-5}$ | 0.19 | -- | -- |
| MW3S | 27.0-27.5 | Brown fine to coarse moist dense SAND and fine gravel, trace silt, clay | 39 | 51 | 8 | 2 | -- | 146.9 | 6.9 | $8.9x10^{-5}$ | 0.15 | -- | -- |
| MW3S | 27.5-28.0 | Brown fine to coarse moist dense SAND, some fine to coarse gravel, trace silt, clay | 25 | 89 | -- | -- | 6 | 130.7 | 12.8 | $1.9x10^{-3}$ | -- | -- | -- |
| MW6S | 27.5-28.0 | Brown fine to coarse SAND | -- | -- | -- | -- | -- | 127.5 | 12.3 | $3.5x10^{-3}$ | -- | -- | -- |
| MW6S | 28.5-29.0 | Brown fine to coarse SAND, little fine gravel, trace silt, clay | 17 | 79 | -- | -- | 4 | 124.9 | 14.3 | -- | 0.28 | -- | -- |

| BORING NUMBER | DEPTH (ft.) | DESCRIPTION | GRAVEL (%) | SAND (%) | SILT (%) | CLAY (%) | SILT & CLAY (%) | DRY DENSITY (p.c.f.) | WATER CONTENT (%) | HYDRAULIC CONDUCTIVITY (cm./sec.) | POROSITY | ORGANIC MATTER (%) | pH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| MW6S | 29.0-29.5 | Brown fine to coarse SAND, little fine gravel, trace silt, clay | 21 | 71 | -- | -- | 8 | 137.9 | 10.3 | $8.5 \times 10^{-5}$ | 0.19 | -- | -- |
| MW6S | 29.5-30.0 | Brown fine to coarse SAND, trace fine gravel, silt, clay | 4 | 86 | -- | -- | 10 | 131.1 | 10.5 | $4.9 \times 10^{-4}$ | -- | -- | -- |

Appendix D

# Appendix D

# Analytical Data Tables (CD-Rom)