# GEOTECHNICAL INVESTIGATION REPORT

**for**

**EGAN FISH HATCHERY**

Bicknell, Utah

Landmark Project No. 13016

February 6, 2013

*Prepared for:*

Jones & DeMille Engineering
1535 South 100 West
Richfield, Utah 84701

LANDMARK
TESTING & ENGINEERING

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# GEOTECHNICAL INVESTIGATION REPORT

**for**

## EGAN FISH HATCHERY

**Bicknell, Utah**

**Submitted to:**

**Jones & DeMille Engineering**
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**Feb. 6, 2013**

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## GEOTECHNICAL INVESTIGATION REPORT

## EGAN FISH HATCHERY - BICKNELL, UTAH

## 1.0 INTRODUCTION

This report presents the results of Landmark Testing & Engineering's geotechnical investigation for the proposed building to cover the Egan fish hatchery raceways in Bicknell, Utah. Figure 1 is a Vicinity map showing the location of the project relative to surrounding features. Figure 2 is a Site Plan showing the proposed layout of the project. Figure 2 also shows the approximate location of the investigatory borings completed for this investigation.

This investigation was completed to assist in developing opinions and recommendations concerning site earthwork and foundation design.

## 2.0 PROPOSED CONSTRUCTION

We understand that proposed development will consist of steel building, approximately 200 ft by 450 ft in plan, to cover the fish raceways at the hatchery. The building will be largely supported by perimeter and interior columns. Maximum column loads are expected to be on the order of 50-80 kips and maximum loads on continuous footings are expected to be on the order of 2 kips per lineal foot.

Any significant changes to the anticipated loads should be reviewed by Landmark to evaluate the continued applicability of the recommendations contained in this report.

## 3.0 SITE SETTING

### 3.1 SURFACE CONDITIONS

The project is located approximately 3 miles south of Bicknell, Utah as shown on Figure 1. The raceways are oriented northeast/southwest as shown on Figure 2 and the building will cover the raceways. The raceways are generally comprised of four sections with each section stepped down to the northeast by approximately 1.5 to 2 feet for a total elevation change of about 6-8 feet from west to east along the raceways. Currently, asphalt access roads surround the raceways. The upper 1.5 feet of the site were frozen at the time of our investigations.

## 3.2 SEISMICITY AND FAULTING

Seismicity at the site was determined using the United States Geological Survey, Earthquake Hazards Program website. The following values are presented to assist with seismic design:

- Latitude= 38.2936, Longitude= -111.5494
- Site Class = D - Stiff Soil Profile

| Period (sec) | Sa (g) | Site Class |
|---|---|---|
| 0.2 | 0.580 $S_S$ | B |
| 1.0 | 0.164 $S_1$ | B |
| 0.2 | 0.516 $SD_S$ | D |
| 1.0 | 0.235 $SD_1$ | D |

(2009 International Building Code Seismic Design Provisions from USGS Java Ground Motion Parameter Calculator - Version 5.1.0)

The project site lies along the southeast edge of the Bicknell bottoms. The Thousand Lake fault is the closest mapped Quaternary fault and is located approximately 8 miles east of the site. Hecker (1993)[1] indicates that the Thousand Lake fault is late Quaternary with up to 250 feet displacement across the fault. Although, the potential for surface rupture is remote strong ground motion associated with movement along existing faults is possible.

## 3.3 LIQUEFACTION POTENTIAL

Groundwater at the site ranges from approximately 4 to 8 feet below the existing grade. The majority of soils encountered throughout the site is classified as silty sand with fines content ranging from about 10 to 25 percent. A liquefaction assessment was completed using the Simplified Empirical Procedure developed by Seed et al.(1985)[2]. The silty sand intervals in borings B-3 at 9-15 feet and B-4 at 9-12 feet have a factor of safety less than 1.0 and could possibly liquefy under the evaluated seismic conditions.

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[1]Hecker, S., 1993, Quaternary Tectonics of Utah with Emphasis on Earthquake-Hazard Characterization; Utah Geological Survey, Bulletin 127.

[2]Seed, H.B., Tokimatsu, K., Harder, L.F., and Chung, R.F., 1985, Influence of SPT Procedures in Soil Liquefaction Resistance Evaluations: Journal of Geotechnical Engineering Division, ASCE, Vol. 11, No. 12, pp 1425-1445.

Potential seismically-induced settlement of saturated sand in level areas was estimated using the Tokimatsu and Seed (1987[3]) procedure. Assuming a 15 feet thick layer, an $(N1)_{60}$ value of 10 (considering up to 20% fines), and a cyclic stress ratio of 0.24, a volumetric strain of 2.5% would be anticipated. Assuming that any non-liquefiable layers above the liquefiable layer do not account for any bridging effect, potential settlement of approximately 4-5 inches could be realized under severe seismic conditions.

### 3.4 SUBSURFACE CONDITIONS

Five borings were excavated to characterize subsurface conditions. The approximate investigation locations are shown on Figure 2. Logs of the investigations are shown on Figures 3 through 7. A key to the descriptions on the investigation logs is presented on Figure 8.

Soils encountered throughout the project generally consist of the following:

- Poorly graded to silty sand (SP-SM) - Encountered near-surface in boring B-1. This material was dense but probably frozen.
- Silty sand (SM) – Silty sand was encountered throughout the majority of the site. The fines content in the silty sand ranged from 16 to 25 percent and the amount of gravel ranged from 0.0 to 22 percent. This material was loose to dense and tended to flow into the augers due to the pressure differential where loose intervals were encountered.
- Clayey sand (SC) - This material was encountered in the bottom of boring B-2 and near the top of boring B-4. The plasticity index ranged from 6 to 16 and this material was medium dense.
- Organic silt - A layer of organic silt was encountered in boring B-3 at approximately 5 feet. This material was black with an organic smell and was likely a deposit of vegetation that has decomposed.

Groundwater was encountered from between 4 to 8 feet below the existing surface grade.

## 4.0 LABORATORY TESTING

Laboratory tests included mechanical gradation analyses and Atterberg limits to aid in soil classification, unit weight and percent moisture to assess in-place conditions, and a soluble sulfate test to assess the corrosion potential of site soils on concrete. Results of the laboratory tests are shown on the investigation logs and on the table presented on Figure 9.

[3]Tokimatsu, K. and Seed, H.B., 1987, Evaluation of Settlement in Sands Due to Earthquake Shaking; Journal of Geotechnical Engineering Division, ASCE, Vol. 113, No. 8, August

## 5.0 FOUNDATION AND CONSTRUCTION CONSIDERATIONS

Maximum isolated column loads ranging from 50-80 kips are anticipated and maximum loads on continuous footings at 2 kips per lineal foot. To adequately support anticipated loads we recommend that foundations be supported on a minimum of 2 feet of imported, granular structural fill overlying native silty sand.

Groundwater was encountered at depths ranging from 4 to 8 feet below the existing surface grade. With a recommended frost depth of 3.0 feet, excavations to allow for 2 feet of imported structural fill beneath the footings may encounter groundwater. Due to the potential of saturation of the imported, granular, structural fill; we recommend that the granular, structural fill consist of well-graded 1-4 inch diameter drain rock with fines content less than 5 percent. Rock should be competent material that will not break down in water. Shale, siltstone, claystone or other material that will deteriorate in water should not be used. Where possible, the rock should be crushed material with fractured aggregate faces.

Placement of granular structural fill below the water table will not allow for density testing, however, the granular nature will allow for grain-to-grain contact with minimal compactive effort. The granular, structural fill rock should be adequately compacted with a plate compactor or walk-behind vibratory compactor. Some of the granular, structural fill will be incorporated into the underlying silty sand, however, the fill should be compacted to a firm, unyielding surface. Imported structural fill should extend at least six inches beyond the foundation for each foot of fill depth below the footings. Concrete should not be placed in standing water.

Concrete sidewalks and walkways may be established on near-surface silty sand where the upper 12-inches have been scarified, moisture conditioned to within 2% of the optimum moisture content, and compacted to a minimum of 95% of the maximum dry density as determined by ASTM D-1557.

### 5.1 FOUNDATION DESIGN

The proposed structure may be supported on conventional spread or continuous footings established on suitable structural fill as shown above. Foundation excavations should be visually observed by qualified

personnel prior to placement of reinforcing steel or concrete. Additional foundation recommendations are subsequently presented.

| DESCRIPTION | VALUE |
|---|---|
| Foundation Type | Continuous or spread footings on structural fill |
| Bearing Material | 2 feet of granular, structural fill with rock fragments 1-4 inches in dimension |
| Allowable Bearing Capacity | 1800 psf for isolated footings up to 6.5 feet square (80 kips) |
| Minimum embedment depth below finished grade | 3.0 feet (for frost and confinement) |
| Minimum footing width | 12 inches (continuous) for single-story, 18-inches for two stories, 24-inches (isolated spread) |
| Total estimated settlement | 1-inch |
| Total differential settlement | less than 3/4 inch |

The allowable bearing capacity is based upon dead load plus long term live load. A one-third increase in allowable bearing capacity may be used for short duration loads, such as wind or seismic loads. For column loads in excess of 80 kips additional depth of imported structural fill will be required and dewatering of foundation excavations will be necessary. Columns with loads significantly larger than 80 kips should be dealt with on a case-by-case basis, however, loads in excess of 100 kips may required deep foundations.

## 5.2 FILL PLACEMENT AND COMPACTION

All fill to be placed for support of footings will likely be saturated and should consist of well-graded, angular gravel with individual fragments 1-4 inches in maximum dimension. Testing of granular, structural fill with a nuclear density gauge will not be possible, however, the fill should be compacted to a firm, unyielding surface prior to concrete placement. Samples of structural fill should be submitted for approval prior to

transporting to the site. All structural fill should be evenly spread on a horizontal plane in eight-inch loose lifts and compacted.

## 6.0 LATERAL EARTH PRESSURES

Lateral loads imposed on footings may be resisted by the development of passive earth pressures against the sides of footings and friction between the base of the footing and the supporting soils. Lateral earth pressure values are presented in the following table:

| Case Evaluated | Soil Type | Value |
|---|---|---|
| Active | Silty sand | 38 psf/ft |
| | | 61 psf/ft (with seismic) |
| At-Rest | Silty sand | 58 psf/ft |
| Passive | Silty sand | 345 psf/ft |
| | | 288 psf/ft (with seismic) |
| Coefficient of friction tan($\phi$ x 0.6), where $\phi$= 34° | Granular (import) | 0.38 |

The lateral earth pressures presented do not include any safety factors except where the friction angle ($\phi$) used to determine the coefficient of friction has been multiplied by 0.6 to account for smooth concrete conditions. The lateral earth pressures presented do not include any safety factors. The pressures also assume horizontal backfill behind the walls and the walls are in a drained condition with no build-up of hydrostatic pressure behind the wall. The additional effects of sloping backfill, surcharge, structural loads and groundwater conditions should be included in calculating lateral earth pressures. Backfill should be placed in accordance with the requirements of structural fill except that backfill in landscape and areas that will not be subject to structural loadings may be reduced to 90% of the maximum dry density as determined by ASTM D-1557.

## 7.0 CUT AND FILL SLOPES

Due to the relatively flat layout of the project, maximum cuts and fills are expected to be on the order of one foot. It is recommended that permanent cut or fill slopes be maintained at a slope of one vertical to two horizontal (1V:2H) or flatter unless structurally retained. Grading of both cut and fill slopes should be such that surface water is directed away from the slopes and not concentrated on slopes or in unprotected channels. Construction procedures should ensure adequate compaction of slope faces. All excavations should conform to OSHA standards.

## 8.0 MOISTURE CONTROL

The water table was encountered at 4 to 8 feet below the existing surface grade. Due to the nature of the facility the likelihood of saturating subgrade soils is very high, however, moisture and drainage should be controlled as much as practical. The following moisture control measures are recommended:

(1) The ground surface should be graded to drain surface water away from the building in all directions. A minimum grade of 5% (IBC 1803.3) in the first 10 feet is recommended except in ramp areas subject to ADA restrictions. Impervious surfaces such as concrete walkways or asphalt pavement adjacent to the structure are effective in reducing the potential for water migration beneath foundations and slabs and should be considered in design. Impervious surfaces such as asphalt or concrete within 10 feet of the building foundation should be sloped a minimum of 2% away from the building.

(2) Roof runoff should be collected and discharged well outside of the backfill limits. Alternatively, roof runoff may discharge on impervious surfaces sloped away from the foundation. Water should not be allowed to pond on the site or adjacent to footings or structurally placed fill.

(3) Inadequate compaction of foundation backfill and utility trench backfill provides a conduit for water migration. All utility trenches within the building footprint and extending 5 feet beyond the footprint should be backfilled with properly compacted structural fill. Backfill adjacent to structures should be compacted to at least 90 percent of the maximum dry density as determined by ASTM D-1557 and the minimum slope requirements should be followed. Backfill beneath structures and pavements should be compacted to at least 95% of the maximum dry density.

## 9.0 SOIL CORROSIVITY

Tests completed on a silty sand sample from boring B-5 at 0.5 feet had a water soluble sulfate percentage of 0.11. Sulfate exposure classifies as moderate. We recommend that concrete mixes in contact with site

soils or groundwater be designed in accordance with ACI 318, Section 4.3 for "moderate" sulfate exposure. Buried pipes should be plastic (PVC or HDPE) instead of metal, where possible.

## 10.0 FOUNDATION REVIEW AND TESTING

This report has been prepared to assist in project design and construction. Variations from the conditions portrayed in the exploratory investigations may occur which are sometimes sufficient to require modifications to the design. In order to incorporate recommendations provided into actual field conditions and to confirm that the project specifications are implemented, we recommend that observation and testing be performed during construction to monitor over-excavation, grading, and preparation of soils upon which foundations elements or structural loads may be established.

## 11.0 LIMITATIONS

The exploratory data presented in this report were collected to provide geotechnical design recommendations for this project and subsurface site descriptions represent conditions observed at the time and at the locations explored. The investigations may not be indicative of subsurface conditions beyond the investigation location and conditions may change with passage of time. If subsurface conditions are encountered that are significantly different than those reported herein, Landmark should be contacted immediately for the continued applicability of the recommendations. In the event changes to the project are made that differ from those presented in this report, Landmark should be made aware of the changes. Landmark will provide written verification that the recommendations and conclusions remain valid or that modifications are required.

This report has been prepared to assist in project design and construction. We respectfully request the opportunity to review the final design drawings and specifications in order to determine whether the assumptions and recommendations presented herein are applicable to the anticipated designs.

This report is not intended to be used as a bid document. Any information concerning the environmental conditions of the site is beyond the scope of this geotechnical study. This geotechnical report has been prepared to meet the specific needs of our client and may not be appropriate to satisfy the needs of other users.

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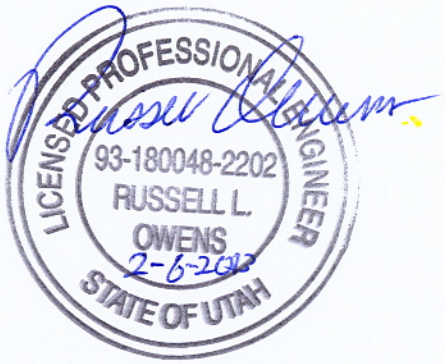
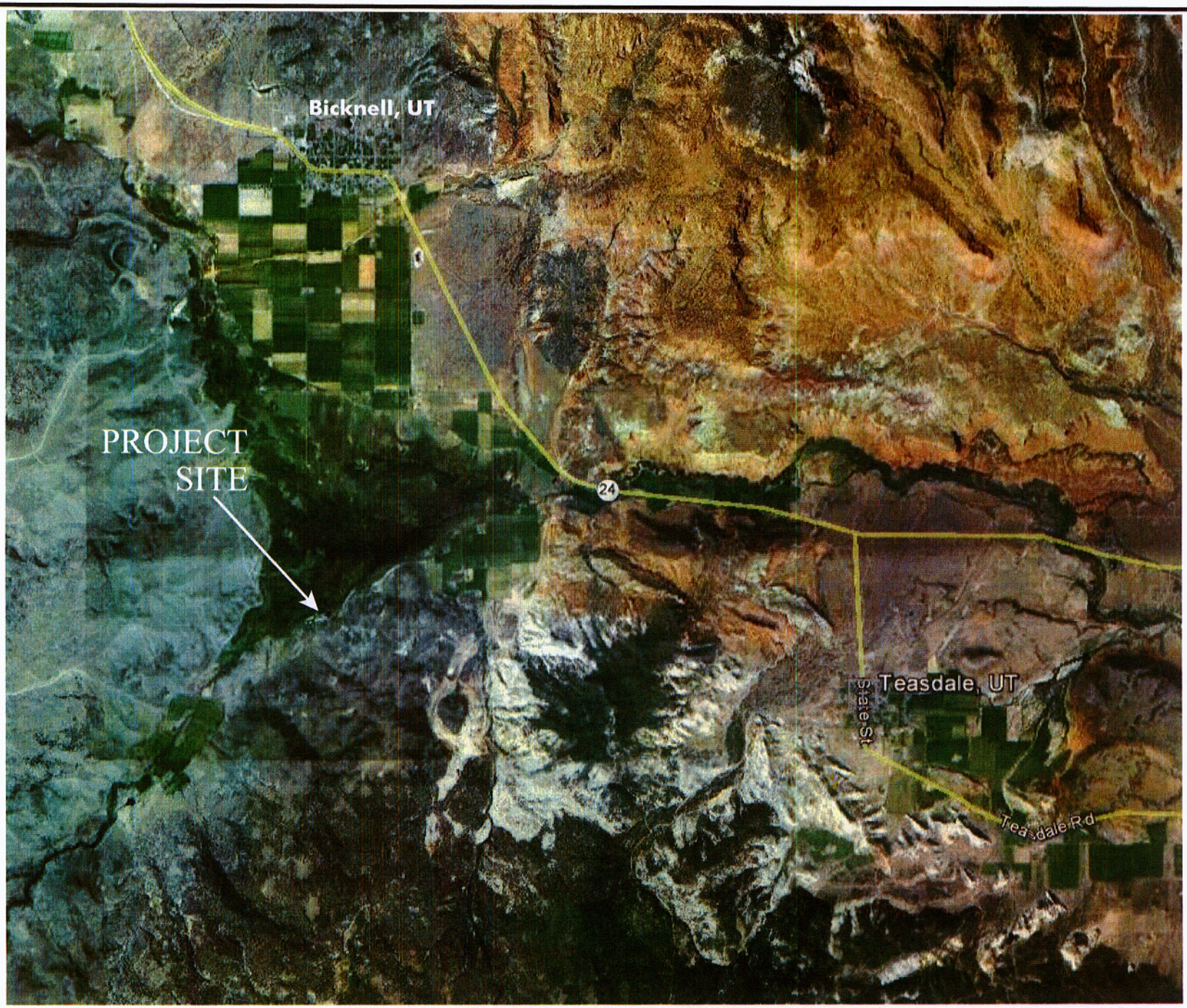



Russell Owens, P.E.
Geotechnical Manager

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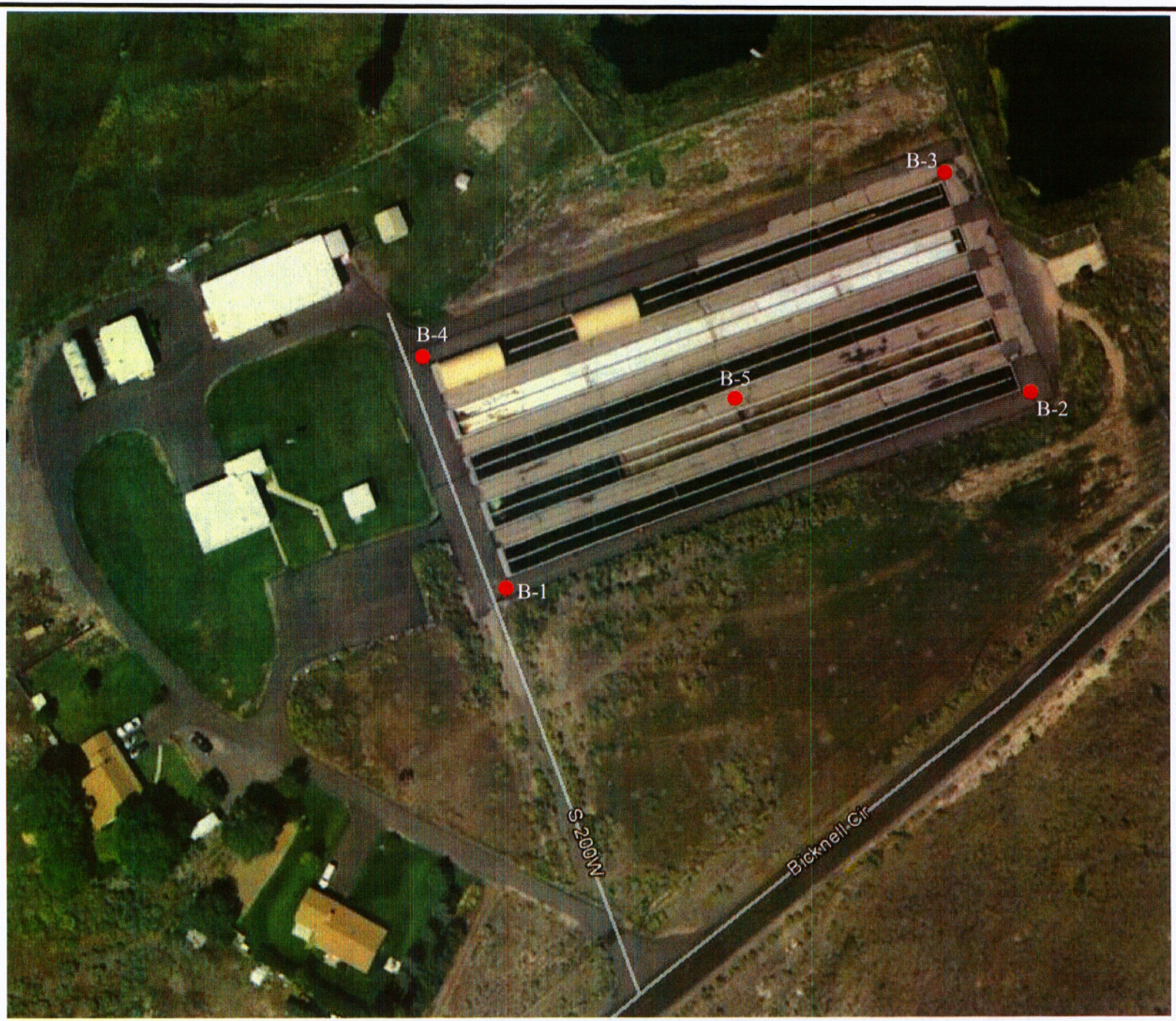
# VICINITY MAP

LANDMARK PROJECT 13016

FIGURE 1

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# SITE PLAN

LANDMARK PROJECT 13016

FIGURE 2

| LABORATORY RESULTS | | | | | | | | | SAMPLE DATA | | | | | | **B-1** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DEPTH (FT) | % GRAVEL | % SAND | % FINES | LIQUID LIMIT | PLASTIC LIMIT | PLASTICITY INDEX | DRY UNIT WEIGHT (PCF) | MOISTURE CONTENT | % COLLAPSE AT 2000 PSF LOAD | EQUIVALENT SPT BLOWCOUTS | SAMPLE DEPTH (FT) | SAMPLE NUMBER | SAMPLE TYPE | LITHOLOGY | USCS | FIELD DATE: January 22, 2013<br>SURFACE ELEVATION:<br>DESCRIPTION |
| 0 | 47 | 48 | 5 | | | | | 11.0 | | +100 | 0.5 | 1 | | | SP-SM | POORLY GRADED SAND WITH GRAVEL (SP-SM), gray, dense (frozen), |
| 5 | 22 | 68 | 10 | | | | 107.3 | 10.1 | | 42 | 5.0 | 2 | | | SM | SILTY SAND WITH GRAVEL (SM), gray, minor volcanic gravel, dense. |
| | | | | | | | | | | | | | | | | Water level at approximately 8 ft |
| 10 | | | | | | | | | | 8 | 10.0 | 3 | | | | grades with up to 15% gravel, sand flows up into augers due to pressure differential, loose. |
| 15 | | | | | | | | | | 23 | 15.0 | 4 | | | | medium to coarse sand, volcanic gravel in bottom of sampler, medium dense |
| | | | | | | | | | | | | | | | | Boring completed to 16.5 feet. Groundwater at 8 feet. |
| 20 | | | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | | | |

**EGAN FISH HATCHERY - Bicknell, Utah**

**Landmark Project # 13016**

**BORING LOG - B-1 - Southwest Corner**

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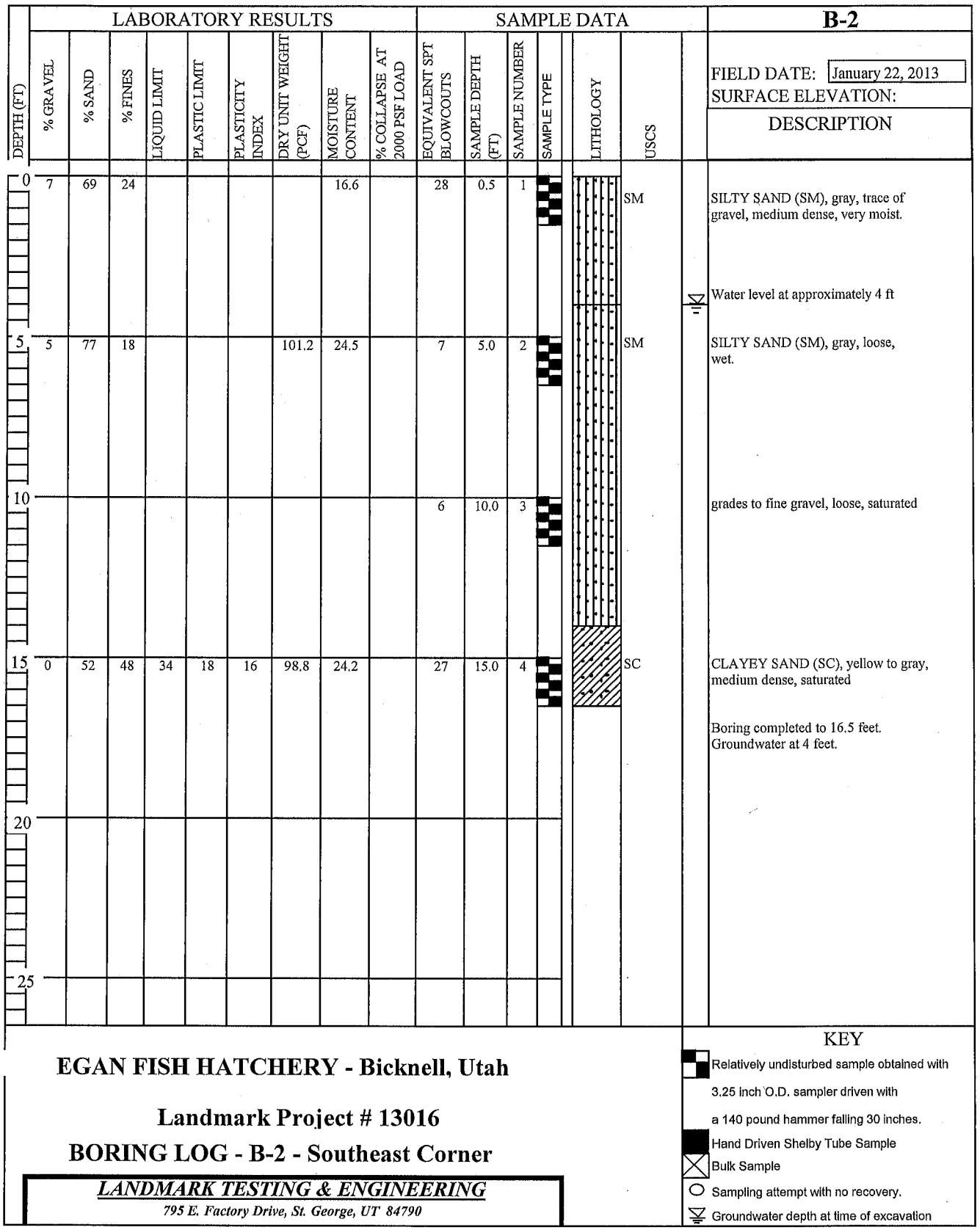
KEY

- Relatively undisturbed sample obtained with 3.25 inch O.D. sampler driven with a 140 pound hammer falling 30 inches.
- Hand Driven Shelby Tube Sample
- Bulk Sample
- Sampling attempt with no recovery.
- Groundwater depth at time of excavation

FIGURE 3




**EGAN FISH HATCHERY - Bicknell, Utah**

**Landmark Project # 13016**

**BORING LOG - B-2 - Southeast Corner**


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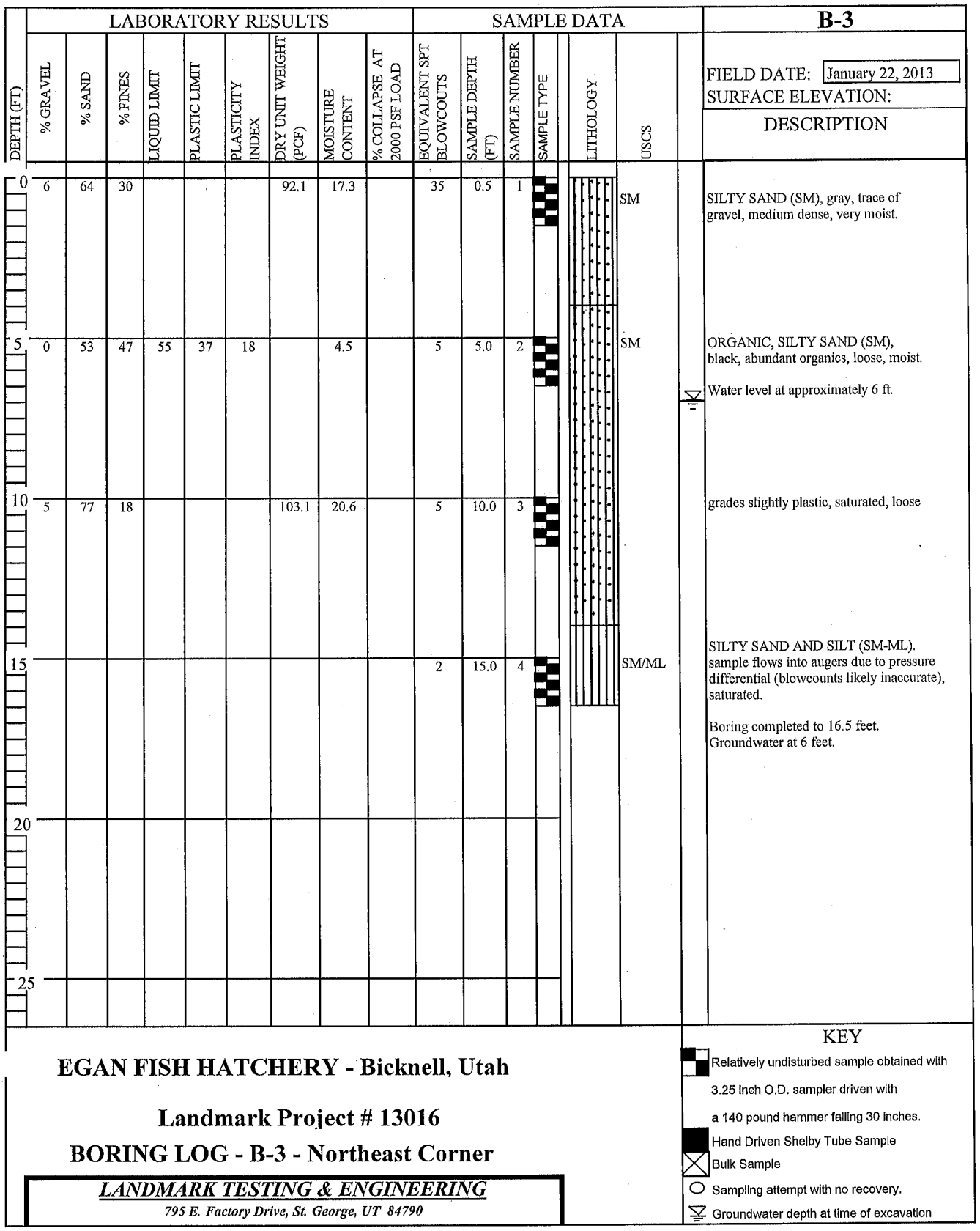
FIGURE 4




**EGAN FISH HATCHERY - Bicknell, Utah**

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**BORING LOG - B-3 - Northeast Corner**


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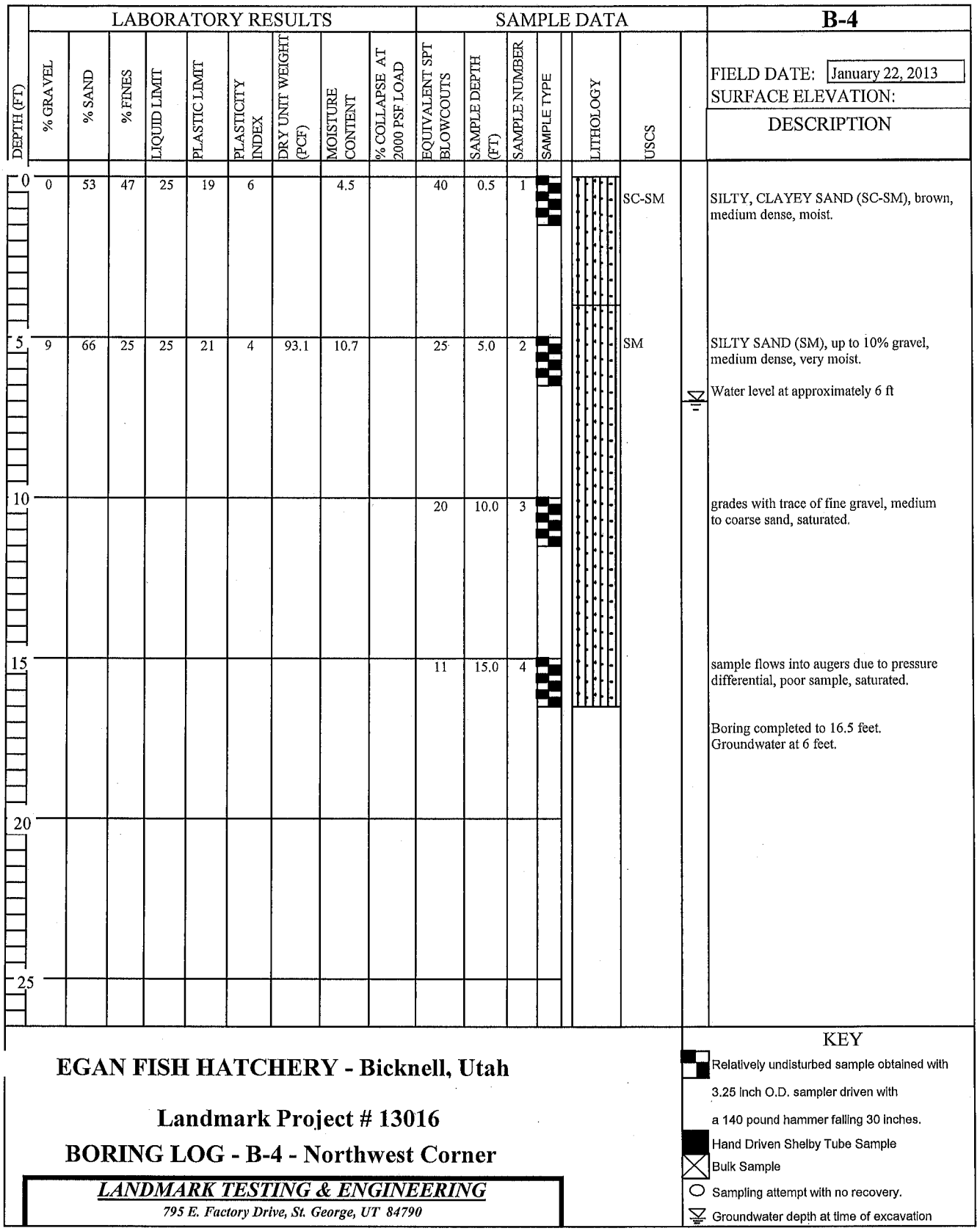
FIGURE 5

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**BORING LOG - B-4 - Northwest Corner**


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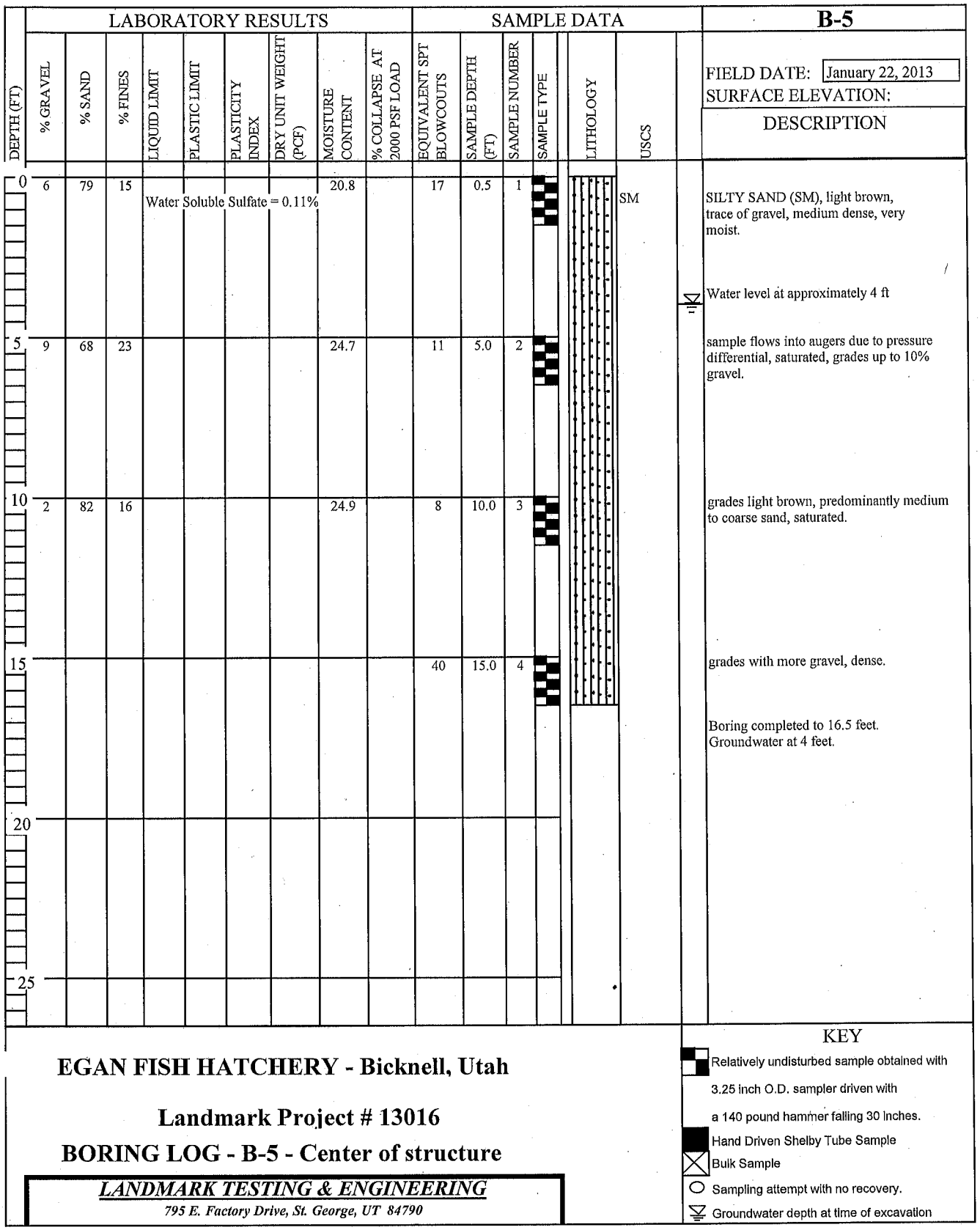
FIGURE 6




**EGAN FISH HATCHERY - Bicknell, Utah**

**Landmark Project # 13016**

**BORING LOG - B-5 - Center of structure**


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FIGURE 7

## UNIFIED SOIL CLASSIFICATION SYSTEM

| MAJOR DIVISIONS | | SYMBOL | TYPICAL NAMES |
|---|---|---|---|
| COARSE-GRAINED SOILS (More than 1/2 of soil > No.200 sieve size) | **GRAVELS** (More than 1/2 of coarse fraction > No. 4 sieve size) | GW | Well graded gravels or gravel-sand mixtures little or no fines |
| | | GP | Poorly graded gravels or gravel-sand mixtures, little or no fines |
| | | GM | Silty gravels, gravel-sand-silt mixtures |
| | | GC | Clayey gravels, gravel-sand-clay mixtures |
| | **SANDS** (More than 1/2 of coarse fraction < No. 4 sieve size) | SW | Well graded sands or gravelly sands, little or no fines |
| | | SP | Poorly graded sands or gravelly sands, little or no fines |
| | | SM | Silty sands, sand-silt mixtures |
| | | SC | Clayey sands, sand-clay mixtures |
| FINE-GRAINED SOILS (More than 1/2 of soil < No.200 sieve size) | **SILTS & CLAYS** Liquid Limit <50 | ML | Inorganic silts and very fine sands, rock flour, silty fine sands or clayey silts with slight plasticity |
| | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandys clays, silty clays, lean clays |
| | | OL | Organic silts and organic silty clays of low plasticity |
| | **SILTS & CLAYS** Liquid Limit >50 | MH | Inorganic silts, micaceous or diatomaceous fine sand or silty soils, elastic silts |
| | | CH | Inorganic clays of high plasticity, fat clays |
| | | OH | Organic clays of medium to high plasticity, organic silty clays, organic silts |
| **HIGHLY ORGANIC SOILS** | | PT | Peat and other highly organic soils |

**GRAIN SIZE CHART**

| CLASSIFICATION | RANGE OF GRAIN SIZE | |
|---|---|---|
| | U.S. Standard Sieve Size | Grain Size in Millimeters |
| **BOULDERS** | Above 12" | Above 305 |
| **COBBLES** | 12" to 3" | 305 to 76.2 |
| **GRAVEL** | 3" to No.4 | 76.2 to 4.76 |
| Coarse | 3" to ¾" | 76.2 to 19.1 |
| Fine | ¾" to No.4 | 19.1 to 4.76 |
| **SAND** | No.4 to No.200 | 4.76 to 0.074 |
| Coarse | No.4 to No.10 | 4.76 to 2.00 |
| Medium | No.10 to No.40 | 2.00 to 0.420 |
| Fine | No.40 to No.200 | 0.420 to 0.074 |
| **SILT & CLAY** | Below No.200 | Below 0.074 |

**Hardness of Rock**

| Descriptive Term | Characteristics |
|---|---|
| Moderately Hard | Can be scratched with a knife with light to moderate pressure; breaks with moderate hammer blow. |
| Hard | Can be scratched with a knife with difficulty; can be broken with heavy hammer blow. |
| Very Hard | Cannot be scratched with a knife; can only be broken with repeated heavy hammer blows. |

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**SOIL CLASSIFICATION**

FIGURE 8

**Table 1**

# LABORATORY TEST SUMMARY

**PROJECT** Egan Fish Hatchery - Bicknell, Utah PROJECT NO. 13016

CLIENT Jones & DeMille Engineering

| BORING/ TEST PIT NO. | DEPTH BELOW GROUND SURFACE (ft.) | IN-PLACE DRY DENSITY (PCF) | MOISTURE CONTENT (%) | % COLLAPSE AT 2,000 PSF LOAD | % WATER SOLUBLE SULFATE | ATTERBERG LIMITS | | | MECHANICAL ANALYSIS | | | USCS GROUP SYMBOL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | LIQUID LIMIT (%) | PLASTIC LIMIT (%) | PLASTICITY INDEX (%) | GRAVEL (%) | SAND (%) | SILT & CLAY (%) | |
| B-1 | 0.5 | | 11.0 | | | | | | 47 | 48 | 5 | SP-SM |
| | 5.0 | 107.3 | 10.1 | | | | | | 22 | 68 | 10 | SM |
| | | | | | | | | | | | | |
| B-2 | 0.5 | | 16.6 | | | | | | 7 | 69 | 24 | SM |
| | 5.0 | 101.2 | 24.5 | | | | | | 5 | 77 | 18 | SM |
| | 15.0 | 98.8 | 24.2 | | | 34 | 18 | 16 | 0 | 52 | 34 | SC |
| | | | | | | | | | | | | |
| B-3 | 0.5 | 92.1 | 17.3 | | | | | | 6 | 54 | 30 | SM |
| | 5.0 | | 4.5 | | | 55 | 37 | 18 | 0 | 53 | 47 | SM |
| | 10.0 | 103.1 | 20.6 | | | | | | 5 | 77 | 18 | SM |
| | | | | | | | | | | | | |
| B-4 | 0.5 | | 4.5 | | | 25 | 19 | 6 | 0 | 53 | 47 | SC-SM |
| | 5.0 | 93.1 | 10.7 | | | 25 | 21 | 4 | 9 | 66 | 25 | SM |
| | | | | | | | | | | | | |
| B-5 | 0.5 | | 20.8 | | 0.11 | | | | 6 | 79 | 15 | SM |
| | 5.0 | | 24.7 | | | | | | 9 | 68 | 23 | SM |
| | 10.0 | | 24.9 | | | | | | 2 | 82 | 16 | SM |
| | | | | | | | | | | | | |
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FIGURE 9