

Date: August 29, 2011

**THE COMMONWEALTH OF MASSACHUSETTS  
UNIVERSITY OF MASSACHUSETTS AMHERST  
PHYSICAL PLANT BUILDING  
PHYSICAL PLANT DIVISION  
360 CAMPUS CENTER WAY  
AMHERST, MASSACHUSETTS 01003-9248**

**ADDENDUM # 1**

**Re: Project: UMAPP12-031  
W.O. #: 11-027065-000  
Account: 105087  
Title: Taylor Field – Design & Install Photovoltaic Array**

The attention of bidders submitting proposals for the above subject project is called to the following addendum to the specifications and drawings. The items set forth herein, whether of omission, addition, substitution, or clarifications are all to be included in and form a part of the proposals submitted.

**ACKNOWLEDGEMENT OF RECEIPT OF THIS ADDENDUM (1) MUST BE REFERENCED IN YOUR BID SUBMITTAL ON SECTION 2.6 OF THE INVITATION TO BID AND BID FORM COVER SHEET.**

Item #1: Reference the contract title **Taylor Field – Design & Install Photovoltaic Array**, and change to **Hadley Farm – Design & Install Photovoltaic Array**. The Taylor Field site will no longer be used for the PV project. Instead three field sites are available at the Hadley Farm on North Hadley Road in Hadley, Massachusetts. These field sites consist of Blocks 1-3, Blocks 37-39, and Block 40, and are shown on the attached Hadley Farm maps.

Item #2: Reference **3.0 GENERAL CONDITIONS**, Section **3.02 PROJECT SITE**, Paragraph **A.**, delete entire sentence, and replace with “The project site is Hadley Farm, located on North Hadley Road in Hadley, Massachusetts.”

Item #3: Reference **4.0 GENERAL REQUIREMENTS**, Section **4.0-2 SCOPE OF SERVICES**, delete all, and replace with the following:

- A. The Contractor shall provide all necessary elements, including labor, equipment, materials, parts, tools, and vehicles, required to design and install a photovoltaic array at Hadley Farm, on North Hadley Road in Hadley, Massachusetts.
- B. The University of Massachusetts (UMA) is seeking proposals to design, procure, install, test, commission, own, operate, insure and maintain a performance-based photovoltaic electrical generating (PV) system. The PV system will also be used as a research station for UMA researchers working on solar power and agricultural programs. UMA is interested in developing a relationship with a PV supplier/contractor to develop a solar array that facilitates research and provides the UMA some of its electricity. The successful bidder shall work with the UMA agricultural researchers to develop a PV system that can be installed on productive agricultural land. The initial intent of the research project is to demonstrate that agricultural land can have solar arrays installed and still be used as productive agricultural land. The UMA is making 31.25 acres of agricultural land available for this project and the successful bidder will enter into a license agreement to install, own and operate the PV array while allowing access to the property for researchers, technical and farm employees.

- C. Develop, design, and install a photovoltaic system located at Hadley Farm, located on North Hadley Road in Hadley, Massachusetts. The design of this PV system shall be developed in cooperation with the UMass Center for Agriculture. This PV system shall be designed in such a way as to allow the full use of Hadley Farm for agriculture while maximizing the electricity generated from the PV system to the fullest extent practical. The successful bidder will have full access to the PV system but must also allow full access to the UMass Center for Agriculture. One, two, or all field sites can be considered for this project. The attached (see Attachment E. in this addendum) shows the approximate PV potential for each field site, giving row length and row number information. For the project emphasizing dual use of land for PV and agriculture we are using inter-panel cluster spacings of 1, 2, 3, and 4 feet for on average an inter-panel spacing of 2.5 feet. A cluster of panels consists of 4 panels stacked vertically with wide edge of the panel to the base of the cluster. Thus, with an assumed panel cluster width of 5.5 feet the average space + the panel width = 8 feet.
- D. By using 8 feet per cluster of 4 panels plus the average inter-panel space (2.5 ft) then you can determine the estimate of panels for each field site. By using a panel wattage of 230w then the estimated output of 8,680 panels in Blocks 1-3 is 1.996 MW; in Block 40 there is potential for 6600 panels for 1.518 MW; and in part of Blocks 37-39 with 7400 there is potential for 1.702 MW. Total estimate production shown in the attached layout gives 5.2 MW.
- E. The minimum height of the lower part of the panel including supporting structure for Blocks 1-3 and Block 40 is 7.5 feet, and in Blocks 37-39 the minimum height is 8.5 feet to accommodate the safe movement of horses.
- F. The attached schematic layout (see Attachment E. in this addendum) also shows details of panel layout and schematic of randomized placement in the field. In the installation process the existing vegetation must be maintained. Normal movement of vehicles is allowable but no excavation for pole placement is allowable.
- G. The successful bidder will work with representatives from the Center for Agriculture, College of Natural Sciences, College of Engineering and research departments to modify the design of the PV system to meet combined research programs at UMass Amherst. The primary research program is to measure the impact on agricultural production of co-locating PV systems and agriculture. The Center for Agriculture has developed a pilot PV system at UMass South Deerfield Farm (89 River Road), and information from this pilot system shall be used in the design of the PV system at Hadley Farm. The successful bidder will work collaboratively with the Center for Agriculture to identify other research projects that could be combined in the solar facility. For example, the deployment of panels should include standard silicon based panels and high-efficiency panels such as emerging thin film technologies to allow a comparison of both, by computer and electrical engineers, under varying light conditions. Similarly, the successful bidder should use a dynamic VAR capable inverter technology with a system level voltage control and power factor control. For better serviceability, the inverter technology should be manufactured in the continental US.
- H. Using what has been learned at the South Deerfield Farm and working with the Center for Agriculture the successful bidder shall develop photovoltaic modules arranged in a non-standard fashion to allow sunlight to pass through the array. This additional spacing between modules was proposed by UMass Amherst to promote vegetative growth under and around the arrays. In a standard array, the PV modules would abut each other. In this configuration the panels are placed apart from each other. The Center for Agriculture's research relates to determining the optimal spacing of PV modules to minimize impacts on the growth of vegetation and agricultural crops beneath the solar array and to maximize electricity production. The successful bidder, during installation, will use procedures and methods that do not disrupt soil or plant life. Installers will install the desired PV facility using non-invasive and vegetation non-disruptive means. Some compaction is anticipated, but it is anticipated that the Center of Agriculture will be able to perform research on living grasses and crops at the site immediately after installation, similar to the South Deerfield site.

- I. The successful bidder will provide all necessary design and equipment needed to fulfill this requirement. The design shall be done by qualified designers registered in the Commonwealth of Massachusetts. All designs shall be submitted to UMass for review and approval by UMass Physical Plant and the Center for Agriculture prior to commencing any work on the project. At the conclusion of the project a complete set of stamped and dated "as built" drawings shall be given to the UMass project manager. The system shall be designed for a 20 year life.
- J. Proposal responders are encouraged to incorporate federal, state tax incentives as well as state, federal and private grant opportunities into submitted work plans. This strategy should also include local utility company programs such as Net Metering and renewable energy credits. For the purpose of this proposal the bidders can assume that the energy produced from the solar facility will be net metered according to the regulations set forth in the Department of Public Utilities regulation 220 CMR 18.00 for Net Metering and the successful bidder shall handle the Net Metering application. UMass will help as needed with the application process but it is the responsibility of the successful bidder to complete the application. Proposal responders are encouraged to be creative and innovative in submittals.
- K. The photovoltaic installation must be properly metered and monitored in order to have electric output qualify for Green Credits.
- L. Successful bidder will be responsible for obtaining all applicable local, state and federal permits for the PV system installation. This includes obtaining an Interconnection System Agreement (ISA) with Western Massachusetts Electric Company, including the required insurance.
- M. Respondents will state the unit cost of power that they intend to charge UMass for power produced by the PV system. UMass will pay the unit cost of power times the amount of power produced each month. All systems shall be designed for a 20 year life, at the end of this agreement UMass will have the option to own the PV system. If research proposed to be done on the PV system will result in a lower power output from the system then the contractor shall inform UMass how much they estimate the reduced power production will be and how much the unit cost of power will change. Any suggested changes in the unit cost of power shall be accompanied by an analysis showing the contractor's original financing plan and how the changes resulting in reduced output effects the original financing plan.
- N. The University expects that the awarded vendor's unit cost of power will be below the University's current purchase cost of power.
- O. While 31.25 acres of Hadley Farm is available to the successful bidder there are wetlands on the property, the successful bidder will determine the acreage that can be developed for this project.
- P. The Contractor's service personnel shall meet with the University Representative, at the beginning and at the end of each work shift to discuss the work and to verify and seek approval for the services performed during each visit to the University.
- Q. Any equipment, materials, or parts, broken or damaged during the performance of any services under the contract, shall be promptly repaired or replaced by the Contractor, at no additional cost and to the University's satisfaction.
- R. Failure of the Contractor to meet all requirements of this section will be cause for termination of the contract.

Item #4: Reference **4.2 EXECUTION**, Section **4.2-1 SCOPE**, delete all and replace with the following:

- A. Requirements of the general conditions and special conditions apply to the work in this section.
- B. Provide all labor, materials, etc. necessary for the completion of the work of this section as specified.
- C. Work of this section consists of, but is not limited to the following:
  - 1. All work to be completed by December 31, 2012.
  - 2. The Contractor, at no additional cost to the University shall replace any items, broken or damaged, including landscaping, sidewalks, and surrounding areas of Hadley Farm during the performance of the work under the contract.

Item #5: Reference **PART 5 ATTACHMENTS, 5.0 ATTACHMENTS**, Section **B. Campus Maps**, delete all, and replace with the attached (3) Hadley Farm Maps.

Item #6: Reference **PART 5 ATTACHMENTS, 5.0 ATTACHMENTS**, add Section **E. Detailed layout of 4-panel clusters showing 1ft and 2ft spacings between panel clusters and Schematic of field layout of randomized replicates of each spacing**, which are attached to this addendum.

Item #7: Reference **PART 5 ATTACHMENTS, 5.0 ATTACHMENTS**, Section A. Request for Proposal, and delete **Introduction, Scope of Services**, and I. PROJECT SCHEDULE in its entirety, and replace with the following:

**Introduction:**

The University of Massachusetts (UMA) is seeking proposals to design, procure, install, test, commission, own, operate, insure and maintain a performance-based photovoltaic electrical generating (PV) system. The PV system will also be used as a research station for UMA researchers working on solar power and agricultural programs. UMA is interested in developing a relationship with a PV supplier/contractor to develop a solar array that facilitates research and provides the UMA some of its electricity. The successful bidder shall work with the UMA agricultural researchers to develop a PV system that can be installed on productive agricultural land. The initial intent of the research project is to demonstrate that agricultural land can have solar arrays installed and still be used as productive agricultural land. The UMA is making 31.25 acres of agricultural land available for this project and the successful bidder will enter into a license agreement to install, own and operate the PV array while allowing access to the property for researchers, technical and farm employees.

**Scope of Services:**

A. Services Required

1. Develop, design, and install a photovoltaic system located on Hadley Farm on North Hadley Road in Hadley, Massachusetts. The design of this PV system shall be developed in cooperation with the UMass Center for Agriculture. This PV system shall be designed in such a way as to allow the full use of Hadley Farm for agriculture while maximizing the electricity generated from the PV system to the fullest extent practical. The successful bidder will have full access to the PV system but must also allow full access to the UMass Center for Agriculture. One, two, or all field sites can be considered for this project. The attached schematic layout (see Attachment E. in this addendum) shows the approximate PV potential for each field site giving row length and row number information. For the project emphasizing dual use of land for PV and agriculture we are using inter-panel cluster spacings of 1, 2, 3, and 4 feet for on average an inter-panel spacing of 2.5 feet. A cluster of panels consists of 4 panels stacked vertically with wide edge of the panel to the base of the cluster. Thus, with an assumed panel cluster width of 5.5 feet the average space + the panel width = 8 feet.

By using 8 feet per cluster of 4 panels plus the average inter-panel space (2.5 ft) then you can determine the estimate of panels for each field site. By using a panel wattage of 230w then the estimated output of 8,680 panels in Blocks 1-3 is 1.996 MW; in Block 40 there is potential for 6600 panels for 1.518 MW; and in part of Blocks 37-39 with 7400 there is potential for 1.702 MW. Total estimate production shown in the attached layout gives 5.2 MW.

The minimum height of the lower part of the panel including supporting structure for Blocks 1-3 and Block 40 is 7.5 feet, and in Blocks 37-39 the minimum height is 8.5 feet to accommodate the safe movement of horses.

The attached schematic layout (see Attachment E. in this addendum) also show details of panel layout and schematic of randomized placement in the field. In the installation process the existing vegetation must be maintained. Normal movement of vehicles is allowable but no excavation for pole placement is allowable.

2. The successful bidder will work with representatives from the Center for Agriculture, College of Natural Sciences, College of Engineering and research departments to modify the design of the PV system to meet combined research programs at UMass Amherst. The primary research program is to measure the impact on agricultural production of co-locating PV systems and agriculture. The Center for Agriculture has developed a pilot PV system at UMass South Deerfield Farm (89 River Road), and information from this pilot system shall be used in the design of the PV system at Hadley Farm. The successful bidder will work collaboratively with the Center for Agriculture to identify other research projects that could be combined in the solar facility. For example, the deployment of panels should include standard silicon based panels and high-efficiency panels such as emerging thin film technologies to allow a comparison of both, by computer and electrical engineers, under varying light conditions. Similarly, the successful bidder should use a dynamic VAR capable inverter technology with a system level voltage control and power factor control. For better serviceability, the inverter technology should be manufactured in the continental US.

3. Using what has been learned at the South Deerfield Farm and working with the Center for Agriculture the successful bidder shall develop photovoltaic modules arranged in a non-standard fashion to allow sunlight to pass through the array. This additional spacing between modules was proposed by UMass Amherst to promote vegetative growth under and around the arrays. In a standard array, the PV modules would abut each other. In this configuration the panels are placed apart from each other. The Center for Agriculture's research relates to determining the optimal spacing of PV modules to minimize impacts on the growth of vegetation and agricultural crops beneath the solar array and to maximize electricity production. The successful bidder, during installation, will use procedures and methods that do not disrupt soil or plant life. Installers will install the desired PV facility using non-invasive and vegetation non-disruptive means. Some compaction is anticipated, but it is anticipated that the Center of Agriculture will be able to perform research on living grasses and crops at the site immediately after installation, similar to the South Deerfield site.

4. The successful bidder will provide all necessary design and equipment needed to fulfill this requirement. The design shall be done by qualified designers registered in the Commonwealth of Massachusetts. All designs shall be submitted to UMass for review and approval by UMass Physical Plant and the Center for Agriculture prior to commencing any work on the project. At the conclusion of the project a complete set of stamped and dated "as built" drawings shall be given to the UMass project manager. The system shall be designed for a 20 year life.

5. Proposal responders are encouraged to incorporate federal, state tax incentives as well as state, federal and private grant opportunities into submitted work plans. This strategy should also include local utility company programs such as Net Metering and renewable energy credits. For the purpose of this proposal the bidders can assume that the energy produced from the solar facility will be net metered according to the regulations set forth in the Department of Public Utilities regulation 220 CMR 18.00 for Net Metering and the successful bidder shall handle the Net Metering application. UMass will help as needed with the application process but it is the responsibility of the successful bidder to complete the application. Proposal responders are encouraged to be creative and innovative in submittals.

6. The photovoltaic installation must be properly metered and monitored in order to have electric output qualify for Green Credits.

7. Successful bidder will be responsible for obtaining all applicable local, state and federal permits for the PV system installation. This includes obtaining an Interconnection System Agreement (ISA) with Western Massachusetts Electric Company including the required insurance.

8. Respondents will state the unit cost of power that they intend to charge UMass for power produced by the PV system. UMass will pay the unit cost of power times the amount of power produced each month. All systems shall be designed for a 20 year life, at the end of this agreement UMass will have the option to own the PV system. If research proposed to be done on the PV system will result in a lower power output from the system then the contractor shall inform UMass how much they estimate the reduced power production will be and how much the unit cost of power will change. Any suggested changes in the unit cost of power shall be accompanied by an analysis showing the contractor's original financing plan and how the changes resulting in reduced output effects the original financing plan.

The University expects that the awarded vendor's unit cost of power will be below the University's current purchase cost of power.

9. While 31.25 acres of Hadley Farm is available to the successful bidder there are wetlands on the property, the successful bidder will determine the acreage that can be developed for this project.

## I. PROJECT SCHEDULE

### A. Schedule:

The following is the planned schedule for the project:

- Advertising Date and Release of RFP to vendors August 17, 2011. Bid Specs may be obtained at the University of Massachusetts-Amherst Procurement Dept., located on the UMass Campus - Goodell Building, Room 407, 140 Hicks Way, Amherst, MA 01003.
- Mandatory Pre-Bid Conference: August 25, 2011 @ 3:00 PM - Physical Plant Conference Room.
- Submission of questions by: vendors September 7, 2011 by 2:00 PM.
- Response to vendor questions by: September 14, 2011 by 4:00 PM.
- Deadline for responses: September 27, 2011 @ 2:00 PM
- Presentation by vendors (if required): Will schedule accordingly.
- Award of contract by: On or about October 1, 2011.

Item #8: Reference INVITATION TO BID AND BID FORM, Section 1.1 INVITATION TO BID, and change the date from September 13, 2011 to September 27, 2011.

Item #9: Reference **BID RESPONSE SECTION**, delete in its entirety, and replace with the following: (*Please use this BID RESPONSE SECTION when submitting bid.*)

## **TABLE OF CONTENTS**

All of the following shall be inclusive of the **BID RESPONSE SECTION** and of the contract, unless otherwise noted:

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### **BID RESPONSE FORMS**

One (1) original and two (2) copies of all pages of this **BID RESPONSE SECTION** and all other documentation required under **PART THREE** and **PART FOUR** of this document shall be submitted at the time of bid.

Each Bidder shall be responsible for filling in all blank spaces of this **BID RESPONSE SECTION**.

The unit price per kwh listed in this document shall not be exceeded during the contract period.

Each Bidder shall be responsible for filling in all blank spaces of **ATTACHMENT A - REQUEST FOR PROPOSAL**.

All figures entered in this document shall accurately reflect all charges for labor, travel expenses, vehicles, equipment, materials, tools, shipping, the prevailing wage, fringe benefits, overhead, insurance, and profit and must be an accurate representation of actual charges for UMAPP12-031- HADLEY FARM – DESIGN & INSTALL PHOTOVOLTAIC ARRAY.

The contract will be awarded based upon the lowest UNIT PRICE COST OF POWER PER KWH, WHICH THE VENDOR WILL CHARGE THE UNIVERSITY OF MASSACHUSETTS, BASED ON THE RFP CRITERIA (ATTACHMENT A).

Failure to submit a bid for UMAPP12-031- HADLEY FARM – DESIGN & INSTALL PHOTOVOLTAIC ARRAY, or failure to provide any documentation or information required under this document, shall result in disqualification of the respective bid.

Any bid showing other than a UNIT PRICE COST OF POWER PER KWH, WHICH THE VENDOR WILL CHARGE THE UNIVERSITY OF MASSACHUSETTS for UMAPP12-031- HADLEY FARM – DESIGN & INSTALL PHOTOVOLTAIC ARRAY under **BID PRICE** of this **BID RESPONSE SECTION**, will be rejected as non-compliant.

## **BR-1**

### **BID PRICE**

The **BID PRICE** shall consist of the unit price cost of power per kwh, which the vendor will charge The University of Massachusetts for UMAPP12-031- HADLEY FARM – DESIGN & INSTALL PHOTOVOLTAIC ARRAY. Each Bidder shall enter the UNIT PRICE COST OF POWER PER KWH, WHICH THE VENDOR WILL CHARGE THE UNIVERSITY OF MASSACHUSETTS for UMAPP12-031- HADLEY FARM – DESIGN & INSTALL PHOTOVOLTAIC ARRAY in the space provided

in **Section 2.2** of the **INVITATION TO BID AND BID FORM** and in the space provided below.

The UNIT PRICE COST OF POWER PER KWH, WHICH THE VENDOR WILL CHARGE THE UNIVERSITY OF MASSACHUSETTS for UMAPP12-031- HADLEY FARM – DESIGN & INSTALL PHOTOVOLTAIC ARRAY

Blocks 1-3 Is: \$ \_\_\_\_\_.

Blocks 37-39 Is: \$ \_\_\_\_\_.

Block 40 Is: \$ \_\_\_\_\_.

### **BIDDER QUALIFICATION STATEMENT**

The Bidder shall submit, with the bid, all documentation required under **Section 4.1-1, QUALIFICATIONS**, of this document.

The Bidder shall enter, in the appropriate spaces provided below, all requested information as documentation of their qualifications and ability to perform the services described in this document. Extra sheets and attachments may be used, as necessary, to provide complete information.

BUSINESS NAME/ADDRESS: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Phone: \_\_\_\_\_

NO. YEARS IN BUSINESS: \_\_\_\_\_

NO. YEARS OF EXPERIENCE: \_\_\_\_\_

### **REFERENCES**

The Bidder shall list below at least three (3) references for whom the Bidder has performed similar services to those specified in this document during the past year.

**REFERENCE #1:** \_\_\_\_\_

ADDRESS: \_\_\_\_\_

CONTACT PERSON: \_\_\_\_\_ PHONE NUMBER: \_\_\_\_\_

WORK PERFORMED: \_\_\_\_\_

DATES OF SERVICE: \_\_\_\_\_

### **BR-2**

**REFERENCE #2:** \_\_\_\_\_

ADDRESS: \_\_\_\_\_

CONTACT PERSON: \_\_\_\_\_ PHONE NUMBER: \_\_\_\_\_

WORK PERFORMED: \_\_\_\_\_

\_\_\_\_\_

DATES OF SERVICE:

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**REFERENCE #3:**

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ADDRESS:

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CONTACT PERSON:

PHONE NUMBER:

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WORK PERFORMED:

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DATES OF SERVICE:

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### PERSONNEL QUALIFICATIONS

The undersigned hereby certifies that he is able to furnish labor that can work in harmony with all other elements of labor or to be employed on the work; that all employees to be employed at the work site will have successfully completed a course in construction safety and health approved by the United States Occupational Safety and Health Administration that is at least 10 hours in duration at the time the employee begins work and shall furnish documentation of successful completion of said course with the first certified payroll report for each employee; and that he will comply fully with all laws and regulations applicable to awards made subject to section 44A.

The undersigned further certifies under the penalties of perjury that this bid is in all respects bona fide, fair, and made without collusion or fraud with any other person. As used in this subsection the word "person" shall mean any natural person, joint venture, partnership, corporation or other business or legal entity. The undersigned further certifies that penalty of perjury that the said undersigned is not presently debarred from doing public construction work in the commonwealth under the provisions of section twenty-nine F of chapter twenty-nine, or any other applicable debarment provisions of any other chapter of the General Laws or any rule or regulation promulgated thereunder.

Date: \_\_\_\_\_

Name of General Bidder: \_\_\_\_\_

By: \_\_\_\_\_

(Name and Title of Person Signing Bid)

Business Address: \_\_\_\_\_

\_\_\_\_\_

Telephone: \_\_\_\_\_

Signed By: \_\_\_\_\_

**BR-3**

The Bidder shall list below or attach a list of names and qualifications of all personnel currently employed by the Bidder, which the Bidder intends to use in the performance of the work specified in this document. The required information shall include the employee's name, trade labor classification, qualifications, length of relevant experience, training, and certifications.

**END OF BID RESPONSE SECTION**

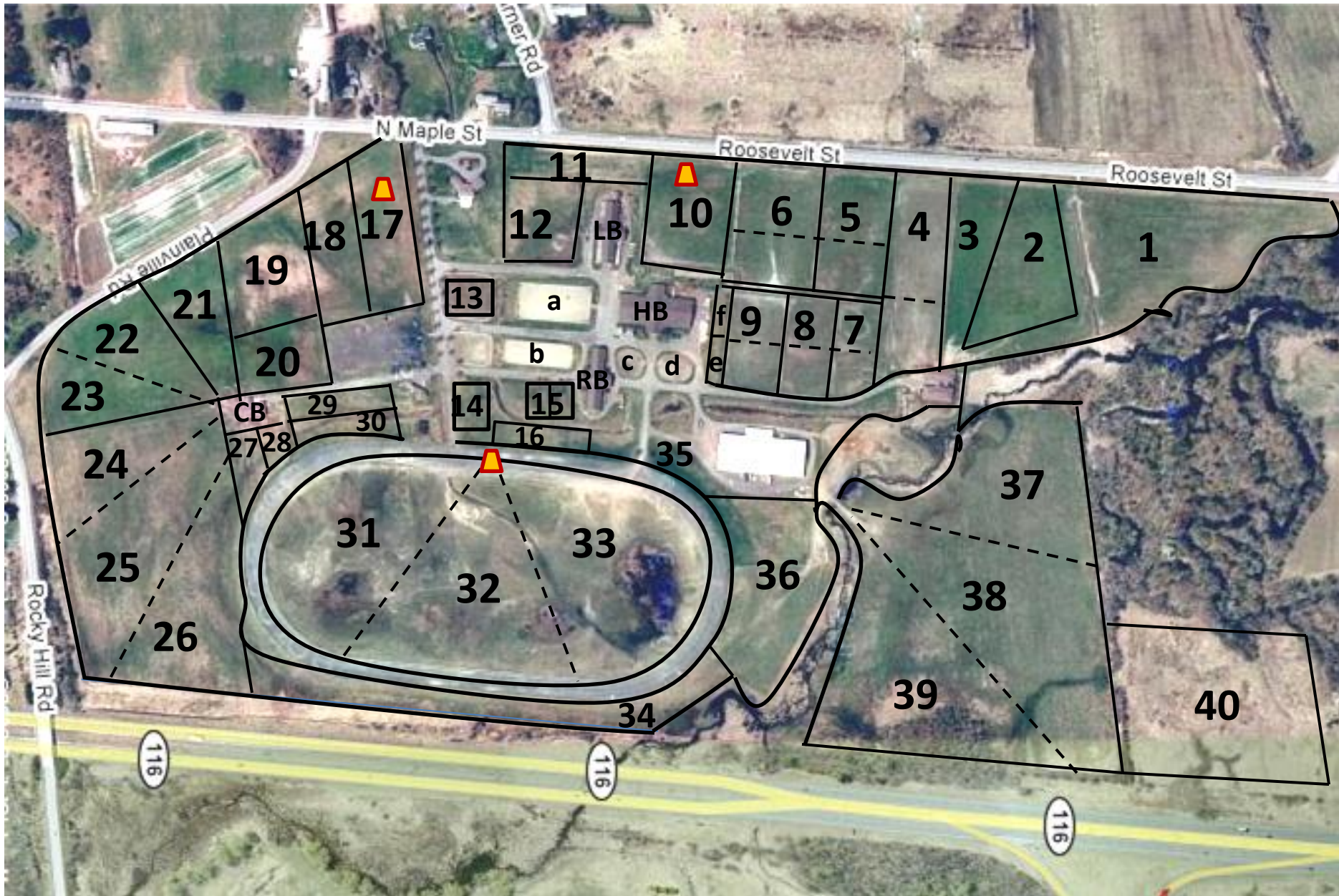
**BR-4**

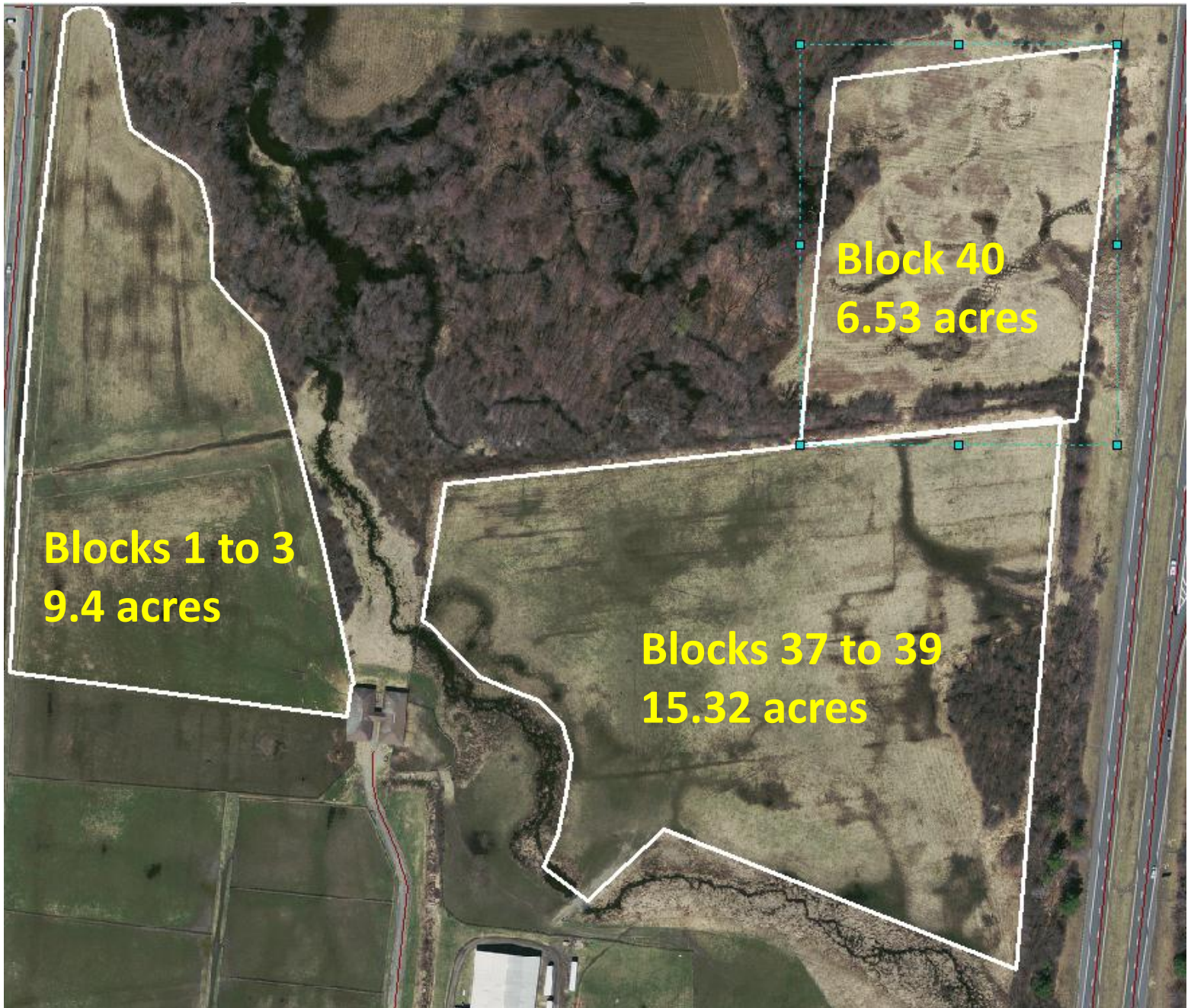
JOHN MARTIN  
Director of Procurement

**END OF ADDENDUM #1**

# UMass Hadley Equine and Livestock Farm

## Blocks for PV 1-3, 40, 37-39 (partial)





**Block 40**  
**6.53 acres**

**Blocks 1 to 3**  
**9.4 acres**

**Blocks 37 to 39**  
**15.32 acres**



N Maple St

N Maple St

200x200  
25 clusters  
X 10 rows

200x300 ft  
37 clusters/row  
X 10 rows

620x400 ft  
50 clusters/row  
X 31 rows  
(20ft between rows)

Total clusters =  
250+370+1550 =  
2170 clusters

Total panels =  
2170 X 4 = 8680

Blocks 1, 2, 3

540x440 ft  
55 clusters/row  
X 30 rows  
(18ft between rows)

Total clusters =  
55 X 30 = 1650

Total panels =  
2170 X 4 = 6600

Block 40

1000ft wide with 125 clusters X 12 rows (20ft between rows)  
= 1500 cluster plus 350 in upper triangle = 1850 clusters  
Total panels = 1850 X 4 = 7400 Blocks 37,38,39

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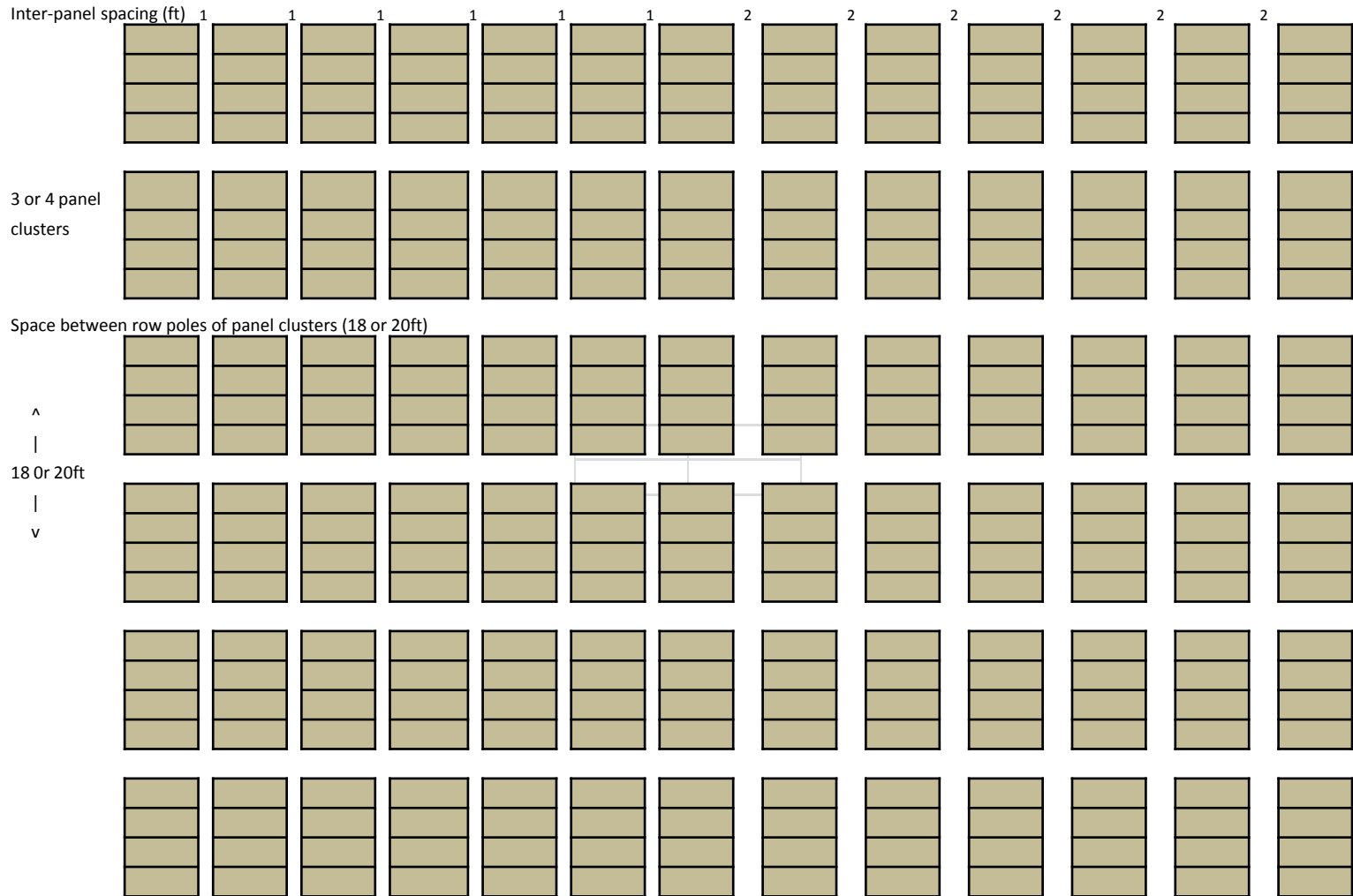
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## Detailed layout of 4-panel clusters showing 1ft and 2ft spacings between panel clusters.



Similar for 3ft and 4ft interpanel spacings. Minimum of 6 interpanel spacings of each distance and 6 rows of each spacing. These 6 rows of each spacing would be repeated in a randomized way throughout the field. See schematic below of field layout of each spacing x 6 rows.

**Schematic of field layout of randomized replicates of each spacing**

(minimum of 6 rows of panel clusters for each spacing - replicates of spacings repeated throughout the field – UMass will assist with this layout in fields)

1ft spacing	3ft spacing	2ft spacing	4ft spacing		
4ft spacing		1ft spacing	2ft spacing	3ft spacing	
3ft spacing		4ft spacing		1ft spacing	2ft spacing
1ft spacing	3ft spacing	2ft spacing	4ft spacing		
3ft spacing		4ft spacing		1ft spacing	2ft spacing





