Memo

To: Amy Moon, EFSEC; Ami Hafkemeyer, EFSEC

From: Dave Kobus, Scout Clean Energy

Cc: Tim McMahan, Stoel Rives; Pat Landess, Scout Clean Energy; Linnea Fossum, Tetra Tech; Troy Rahmig, Tetra Tech

Date: August 9, 2023

Subject: Horse Heaven Wind Farm Anticipated Project Modifications for Final Application for Site Certification

EXECUTIVE SUMMARY

As requested by EFSEC in Data Request 9, this memorandum summarizes changes to the Horse Heaven Wind Farm (Project) made in response to comments received on the application, input from regulatory agencies, changes to applicable regulations, settlement agreements, and information received from the Bonneville Power Administration. Please be aware that this information represents our best understanding at present of changes that are likely to be included in our ASC Amendment, required under WAC 463-60-116, which requires that the Applicant submit 'application amendments which include all commitments and stipulations made by the applicant during the adjudicative hearings'. Because the adjudicative hearings will be ongoing through August 25, it is possible that other changes may be made to the Project or that the changes described here could evolve before the ASC Amendment is submitted. We understand that our formal amendment to the ASC must be provided within 30 days of completion of the hearings.

Additional detail regarding changes to the impact analysis will be developed over the coming weeks. Information provided here represents a preliminary, high-level assessment of the types of changes that we expect based on the modifications. Overall, the changes are expected to result in a net reduction in permanent and temporary disturbance area, a reduction in visual impacts to some viewers, and a reduction in biological impacts to some sensitive resources. As a result, although there will be some very limited new impacts outside the previously surveyed area, the impact analysis presented in our ASC (February 2021, updated December 2022) continues to represent the maximum impact scenario. The limited new impacts described here are more than offset by reductions in impacts for other areas.

Note that in the 2023 Washington legislative session, the legislature passed, and the governor signed, legislation requiring implementation of aircraft detection lighting system (ADLS) technology in order to reduce the duration of nighttime turbine lighting, subject to approval by the Federal Aviation Administration. In order to comply with this new legislation, radar towers, including some located outside of the current micrositing corridor, must be installed. While installation of these towers will include small impacts to account for tower installation and associated electrical and road infrastructure, they will reduce nighttime lighting and consequent nighttime visual impacts that are of concern to local residents.

Attachment 1, Figure 1 provides an overview map of the updated proposed Project, based on Turbine Option 1. Figure 2 provides a detailed mapbook showing the modifications, including what infrastructure has been removed, and where Project elements have been shifted (or in the case of ADLS radar towers, added). Attachment 2 provides information on the ADLS radar towers, and Attachment 3 provides the location of a DNR well that may be used as a water source during construction and operation.

1.0 LAYOUT MODIFICATIONS

1.1 East Solar Array Size Reduction

Planned modification: Remove all solar array infrastructure west of I-82; remove solar infrastructure within approximately 1 mile of I-82 on the east (see area '1' on attached overview map, Attachment 1). This modification will reduce the acreage of the fenced area for this array by approximately 1,398 acres, leaving a total of approximately 639 acres of fenced solar panels. This change will remove infrastructure that would have disturbed Priority Habitats, including rabbitbrush shrubland habitat, in the portion of this array originally proposed west of I-82. Note that temporary disturbance to Priority Habitat areas east of I-82, including temporary laydown areas, will still occur, but there will be no permanent impacts to Priority Habitats in the East Solar Area with this change.

Rationale for change: The original total solar generating capacity at this location was anticipated to be up to 300 MWac. In a settlement agreement, Scout Clean Energy has committed to reduce solar energy generation from this location to approximately 100 MWac (aggregate inverter output) in response to concerns expressed by stakeholders regarding impacts to wildlife connectivity, Priority Habitat, and visual resources in this area. The extent of solar panels and associated infrastructure will be reduced and concentrated in areas with less sensitive habitat (i.e., agricultural lands) and will be located farther from I-82.

Changes to Resource Impacts:

- Reduction in fenced area reduces the impact to habitat connectivity and wildlife movement. The area west of the original solar array is designated as 'high linkage centrality' based on the Arid Lands Initiative (ALI; see Figure 3.4-6 in Updated ASC, December 2022).
- Reduction in permanent and altered habitat impacts in rabbitbrush shrubland and grassland habitats.
- Removal of infrastructure from Priority Habitats.
- Panels will be less visible to drivers on I-82.
- Reductions to other resource impacts would also occur (e.g. reduction in temporary, permanent, and modified habitat disturbances).

1.2 Shift Infrastructure away from Webber and Sheep Canyons

Planned modification: Collector lines and Turbines have been moved farther away from Webber and Sheep canyons (see area '2' on attached overview map). Turbines 8, 18, and 19 were shifted as much as possible from canyon rims while remaining within the bounds of the Department of Defense Mitigation Agreement; see Table 1 for new turbine coordinates. In addition, collector lines originally planned to span the canyons have been re-routed to the south to travel through previously identified micrositing corridors and avoid spanning these canyons.

Rationale for change: Washington Department of Fish and Wildlife requested that Turbines be set back from canyon edges, and that where collector lines are planned to span canyons, they be shifted to be as close as possible to canyon heads to reduce the potential for direct or indirect impacts to wildlife.

Changes to Resource impacts:

- Potential reduction in collision risk and avoidance of raptors using canyons for foraging and move artificial perch structures away from the main canyon area.
- Increased temporary disturbance from underground electrical collector line installation.
- Increased the length of underground collection but reduced amount of overhead collector line that would have spanned the canyons.

1.3 Remove 4 Wind Turbines near Benton City

Planned modification: Remove Turbines 5, 6, 7, and 8 from the proposed layout (see area '3' on attached overview map; see Table 1 for coordinates of Turbines removed from the layout).

Rational for change: Reduce visual impacts to resources of concern to local residents and Yakama Nation. Remove Turbines in proximity to ferruginous hawk historical nesting territories.

Changes to Resource impacts:

- Reduce visual impact due to proximity to resources of concern, primarily visual and biological.
- Reduce temporary (36.9 acres) and permanent (3.9 acres) disturbance areas associated with construction of these Turbines and associated electrical and road infrastructure.
- Avoid north-facing escarpment area that birds (e.g., waterbirds, raptors) may use during migration and native habitats with increased potential to attract raptors during foraging activities.
- Remove Turbines in proximity to 2 historical ferruginous hawk territories including the [redacted] Territory (7 historical nests) and the Webber Canyon Territory (5 historical nests).
- Remove Turbines along the east-west Primary Linkage Area (PLA) modelled by Arid Lands Initiative to minimize impacts to wildlife connectivity and movement.

1.4 Remove Turbine 116

Planned modification: Remove Turbine 116 from the proposed layout (see area '4' on attached overview map; see Table 1 for Turbine coordinates).

Rationale for change: Remove Turbine in closest proximity (approx. [redacted]) to the most recently occupied ferruginous hawk nest, as well as visual impacts to resources of concern to local residents.

Changes to Resource impacts:

- Reduce potential impact to ferruginous hawk, if they return to this nest site.
- Reduce temporary disturbance by 14.8 acres and reduce permanent disturbance by 2.8 acres associated with construction of this turbine and associated electrical and road infrastructure.
- Reduce visual impacts from Turbines to resources of concern to local residents.
- Remove turbine along the north-south Primary Linkage Area modelled by Arid Lands Initiative to minimize impacts to wildlife connectivity and movement.

1.5 Remove Turbines 119, 121,122, 123, 124, 125, 162 & 243

Planned modification: Remove Turbine's 119, 121,122, 123, 124, 125, 162 & 243 (see area '5' on attached overview map; see Table 1 for Turbine coordinates) from the proposed layout.

Rationale for change: Remove Turbine visual impacts to resources of concern to local residents and in proximity to ferruginous hawk core areas.

Changes to Resource impacts:

- Reduce temporary and permanent disturbance associated with construction of these Turbines and associated electrical and road infrastructure.
- Reduce visual impacts from Turbine's to resources of concern to local residents.
- Remove Turbine 119 along the north-south Priority Linkage Area modelled by Arid Lands Initiative to minimize impacts to wildlife connectivity and movement.
- Including Turbine 116, removal of Turbines 119, 121, 122, 123, 124, 125 would reduce approximately 30% of Turbines located within the 3.2 km core area of the Coyote Canyon ferruginous hawk territory.

1.6 Remove duplicate transmission line and substation infrastructure

Planned modification: Remove primary intermediate substation and associated 230-kV and 500-kV transmission line infrastructure; remove step-up substation on Sellards Road (see area '6' on attached overview map).

Rationale for change: BPA has confirmed the location of their new Webber Canyon substation to be close to County Well Road and will not construct a substation on Sellards Road. As a result, the locations of other related infrastructure can be finalized and duplicate/alternate locations can be removed.

Changes to Resource impacts:

- Reduced temporary and permanent impacts from construction of these components.
- Small reduction in visual impacts from removal of substation and transmission line infrastructure.

1.7 Add/modify construction laydown areas

Planned modification: Add locations for Phase 1 and Phase 2 construction laydown; add interim Turbine component laydown area (see area '7' on attached overview map).

Rationale for change: Specific Phase 1 and Phase 2 laydown areas have now been identified as described in the batch plant air modeling analysis provided to EFSEC in response to Data Request 7. In addition, GE has determined that all Turbine components will need to be staged at a central location rather than delivered directly to Turbine locations as needed during construction; this central location has now been identified.

Changes to Resource impacts:

- Temporary disturbance of 83 acres total across the three laydown areas. Areas inside the lease boundary have been mapped and classified as agricultural (generally, cultivated cropland in rotation). The central laydown area that will be used to stage turbine components will occupy 20 acres of land classified by NLCD as 'Cultivated Crops'.

1.8 Add Radar Towers associated with Aircraft Detection Lighting System (ADLS)

Planned modification: Add up to five FAA-compliant ADLS radar sensor units, towers, and associated electrical infrastructure (see Attachment 2 for tower specifications). Radar towers will range in height from 30 feet to 120 feet depending on topography relative to the turbine layout and coverage required by FAA The tower is mounted on a skid base with a NEMA 4 electronics enclosure (3ft by 4ft) and electronics, power, and fiber optic connection boxes. The fiber network will fully integrate the ADLS with the Project SCADA network and can be remotely controlled from the Project Operations and Maintenance building. The system requires 120/230VAC, 30/32A, 60/50Hz, single phase power at the server rack and radar site, which will be connected to the Project collection system. A 20ft by 25ft fence will enclose the system with 7ft minimum distance from the tower ladder. Temporary ground disturbance for tower placement will cover an approximately 12-foot disturbance width to weld each tower piece together before raising and installation. Table 2 provides tower coordinates and expected tower height (above ground surface) for each.

Rationale for change: Washington's new requirement under HB 1173 to include ADLS Turbine lighting restrictions will require placement of additional met towers to determine when aircraft are close enough to the Project to require Turbine lights be illuminated at night.

Changes to Resource impacts:

- Additional 7,705 feet of roads and 10,091 feet of electrical infrastructure associated with new radar towers.
- Minimal change to visual impacts or other resources because of existing infrastructure in these areas and similarity to other infrastructure already analyzed.

1.9 Modify Transmission Line Route to BPA Webber Canyon Substation

Planned modification: Extend the County Well Road 500-kV transmission line route to begin at the Intermediate Substation (p. 4 of Infrastructure Comparison mapbook, Attachment 1) to BPA's planned new Webber Canyon substation. Although the line will now extend slightly further to the south and west to reach BPA's planned new Webber Canyon substation location, immediately west of the Project site boundary, the majority of approx. 4 miles is being upgraded from 230 kV to 500 kV. Modify HH-West Project Substation and battery energy storage location to be closer to the new BPA substation but within the previously surveyed solar siting area. A portion of the new transmission line, including one support structure, will extend outside of the previously surveyed area. See changes shown in area '9' on the attached overview map.

Rationale for change: BPA has concluded its siting analysis for its new substation, which will be permitted under a separate process. BPA's new substation is intended to be located on Washington Department of Natural Resources (DNR) land, south and slightly west of the preliminary location anticipated in our ASC. The applicant will be responsible for constructing the transmission line to reach the new BPA substation.

Based on updated design review conducted by the Applicant, power will be stepped up to 500 kV at the intermediate substation. The Project substation adjacent to BPA's new substation will remain to step up power generated by the solar facility for delivery to BPA.

Changes to Resource Impacts:

- Additional 1,130 feet of transmission line extending outside of the previously surveyed area.
- Permanent impacts from installation of one new support structure outside of the previously surveyed area.
- Minimal change to impacts to other resources.

1.10 Update Fire Protection Systems Information

Planned modification:

As additional battery storage facilities have been constructed around the world in recent years, industry experts including members of the National Fire Protection Association (NFPA) 855 standard committee, members of the International Fire Code standard committee, and the Society of Fire Protection Engineers, have developed updated guidance for fire protection systems at these units based on large scale fire testing results. At the time of the Application for Site Certification in February 2021, Benton County had adopted the 2015 version of the International Fire Code (IFC). This version of the code had no requirements for lithium-ion battery installations. In order to comply with the latest guidance, the Project is updating the thermal runaway mitigation design of its Battery Energy Storage System (BESS) to align with the updated guidance.

Scout will procure batteries that are listed to UL9540,[1] have completed UL9540A large scale fire testing, and are designed in accordance with NFPA 855 2023ed[2] and the 2021 International Fire Code. The battery

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[1] UL9540 is a set of standards that an energy storage system (ESS) must meet. UL9540a is a method of evaluating thermal runaway in an ESS; it provides additional requirements for battery management systems (BMS) used in ESS. UL 9540A will continue to evolve to reflect changes in ESS installation requirements, advancements in fire science, and the needs of the ESS industry and code authorities.

[2] NFPA 855 (Standard for the Installation of Energy Storage Systems) is a National Fire Protection Association Standard developed to define the design, construction, installation, commissioning, operation, maintenance, and decommissioning of stationary energy storage systems including traditional battery systems such as those used by utilities.

enclosures will be installed according to the “remote, outdoor” installation requirements of NFPA 855, including vegetation control to prevent the spread of any fire. The battery enclosures will be equipped with fire detection, but not suppression. Scout will recommend that a fire within a battery enclosure will be allowed to fully consume itself. An Emergency Response Plan will be provided prior to facility operations to train the first responders on the hazards associated with an event.

Additionally, after the full system has been designed but prior to construction, a Hazard Mitigation Analysis will be provided by a licensed fire protection engineer detailing the hazards associated with each failure mode and the associated mitigations. As part of the Hazard Mitigation Analysis, an analysis will be performed using data from the UL9540A fire testing to show that a fire inside one battery enclosure will not propagate to the adjacent battery enclosures. The Hazard Mitigation Analysis will also address the gas composition of venting during a thermal runaway event to ensure the battery siting does not present a risk to public health due to toxic gases.

In addition to updated information for the BESS, as it has been determined that the Project Site is not serviced by an adequate and reliable municipal-type water supply for supplying firewater to the occupied Operations and Maintenance Building, Scout will provide a water tank sized for structural firefighting purposes in accordance with NFPA 1142: Standard on Water Supplies for Rural Firefighting.

The following information will be added to Appendix P (Emergency Response Plan):

Although fires within industrial-scale lithium-ion battery energy storage systems are rare and expected to become even more rare with the updated NFPA 855 and IFC 2021, when fires do occur, these systems present several unique hazards for first responders. Battery cells do not have a single point of disconnect that can be used to de-energize the system. Instead, there will always be stranded energy in the battery cells. The amount of energy is dependent on the state of charge of the batteries at any given time. Additionally, lithium-ion batteries have the potential to enter thermal runaway, which generates heat and flammable gases. If a thermal runaway or fire event begins inside a battery container, the fire detection system will notify site operational personnel and first responders. First responders should not attempt to extinguish the fire or arrest the thermal runaway. The battery containers will be designed to contain the event until it fully consumes itself. Attempting to extinguish the event creates a risk of a deflagration event, which substantially increases the risk to first responders. Applying water to the event also creates the scenario where the event will smolder for days or weeks without being fully extinguished. When the event is allowed to fully consume itself, the duration of the event is only a few hours. Additional training will be provided to the first responders prior to the battery system being placed into commercial operation.

Rationale for change: Fire protection systems best management practices have been evolving in recent years including since the time the ASC was developed in 2020-2021. Fire suppression using either water or aerosol clean agents have been shown to be ineffective at arresting thermal runaway in BESS. Applying water to batteries has caused thermal runaway events to smolder for many days, allowing flammable gases to build up. Aerosol clean agents may prevent a fire, but do not arrest thermal runaway so flammable gases continue to be generated. While both water and aerosol fire suppression methods may prevent flaming, they do not arrest the thermal runaway chemical reaction, and they can increase the risk of a deflagration event. As a result, the best practice for fire protection is now considered to consist of the control measures described above, intended to prevent the spread of fire between containers in the unlikely event that a fire occurs.

Changes to Resource Impacts: No change to previous analysis. This information is provided as information on current best practices based on questions received during the adjudication process.

1.11 Increase the size of the West BESS in concert with the reduction of the East and Southwest BESS

Planned modification: Per Section 2.3.5 of the ASC, three AC-coupled BESS may be developed for the Project, occupying a total of up to approximately 18 acres (ASC Table 2.1-1). The BESS would be capable of storing and later deploying up to 300 MW of energy generated by the Project using lithium-ion batteries. The following changes have been identified affecting both potential BESS facilities:

- The East BESS is being reduced to 100 MWac (on 6 acres).
- The West BESS is being increased to 200 MWac (on 10 acres).
- Modifications in net BESS capacity will occur on agricultural lands and have no effect on Priority Habitats.
- This will result in the combined BESS capacity being maintained at the original 300 MWac sizing across the Project.

Rationale for change: New information received from potential offtakers has caused the optimal sizing of the battery storage for the Project to be adjusted.

Changes to Resource Impacts:

- When combined with the infrastructure reductions identified in Sections 1,1 and 1.6 of this memorandum, results in a net decrease of permanent and temporary disturbance.
- Results in no appreciable change in the previously evaluated footprint of the combined BESS facilities.
- Results in an increase in the footprint of the West BESS facilities and corresponding battery density due to the addition of 50 MWac of battery containers.
- The additional battery storage area would be placed on agricultural land that has already been surveyed and identified in the ASC for potential siting of solar array components and related infrastructure, including battery storage.
- Refer to Section 1.10 of this memorandum which commits to a Hazard Mitigation Analysis to be provided in concert with the negotiation of the Emergency Response Plan.

1.12 Potential Use of DNR Gould Well for Water Supply

Planned modification: Scout is currently working with DNR to assess the potential for a lease agreement that would allow for use of a portion of DNR's existing water right associated with the Gould Well to be used during construction and operation of the Project. The Gould Well is located approximately 2 miles west of the Project lease boundary; see map in Attachment 3. The lease agreement, payment, and any necessary well improvements would be handled through a SEPA process to be conducted by DNR as a separate action because DNR would also make water from this well available to other users during and beyond the time it would be needed for Facility construction.

Rationale for change: Scout continues to explore various options for water supply to the Project during construction and operations in order to minimize the transportation and environmental impact.

Changes to Resource Impacts: The Gould Well is located in close proximity to the Project and its use would result in a net decrease in transportation requirements and environmental impact for water deliveries to the Project. No other changes to resource impacts are anticipated.

Table 1
Coordinates for Turbines Removed or Shifted

Turbine ID	POINT_X	POINT_Y
Turbines Removed from Layout		
5	313141.23890	5120416.18777
6	313539.98513	5120248.32881
7	313788.12312	5120019.79835
8	314150.32135	5119789.01493
9	310959.14587	5119626.54715
18	315018.78120	5117894.42628
19	315060.09726	5117209.61238
116	324022.52940	5109839.52413
119	324928.10673	5108743.10850
121	325679.32694	5108529.57248
122	326045.86511	5108565.40292
123	327128.79186	5107571.63998
124	327416.78530	5108883.54128
125	327851.46742	5108757.45639
162	327995.02724	5106915.97148
243	330284.17503	5109383.34780
Turbines Shifted to New Location		
9	310976.99996	5119601.99987
18	315017.99996	5117919.99993
19	315076.99997	5117198.99988

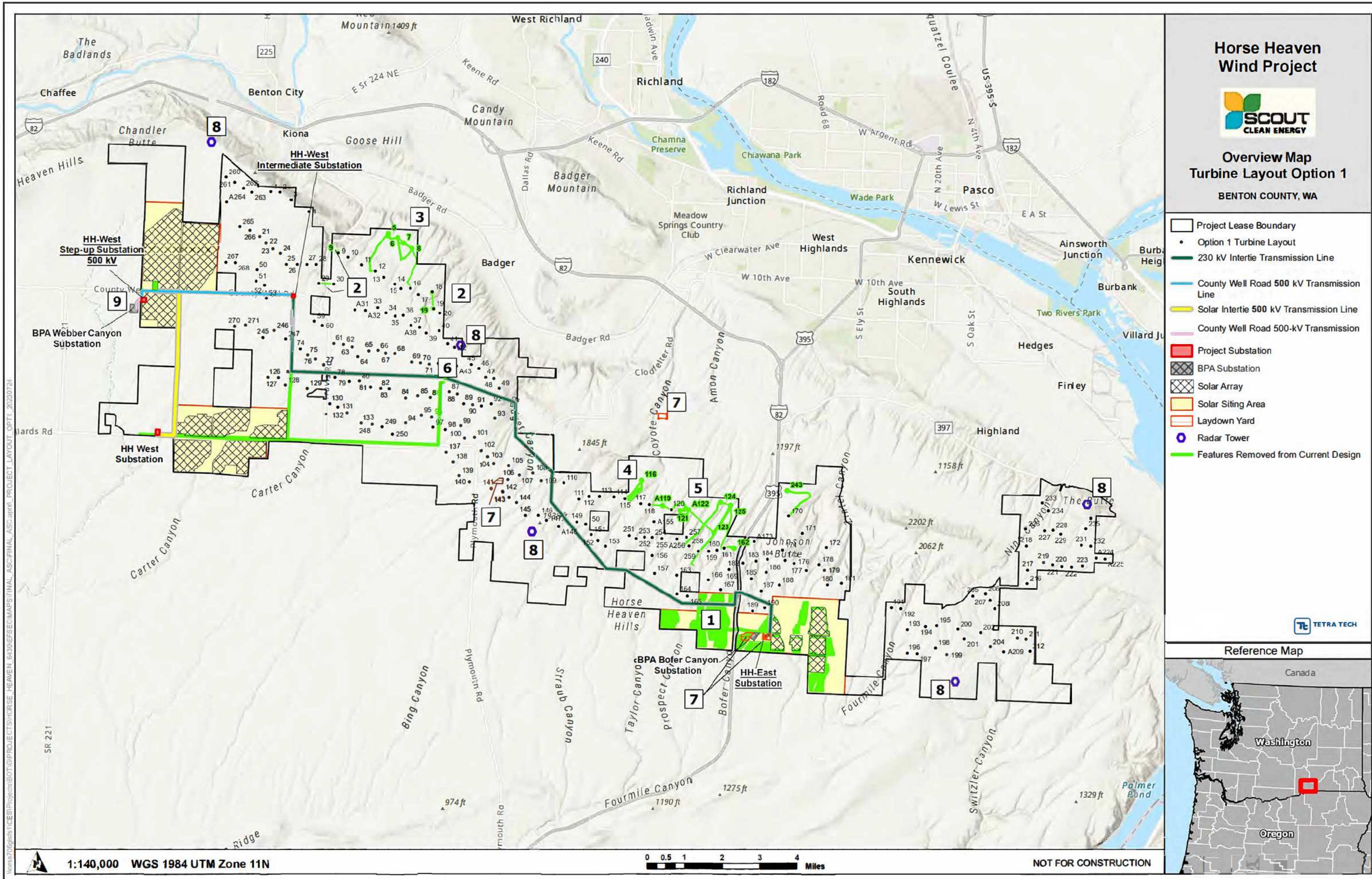
Note: Coordinates in WGS84, UTM Zone 11

Table 2
Coordinates and Height for ALDS Radar Towers

Radar Tower ID	Tower Height (ft)	POINT_X	POINT_Y
Radar 1 – Ph 1	100	343171.98554	5108785.23942
Radar 2 – Ph 1	30	337509.75395	5101159.97881
Radar 3 – Ph 1	30	319313.60316	5107627.09706
Radar 1 – Ph 2	100	316255.02691	5115622.31946
Radar 2 – Ph 2	120	305548.02599	5124375.19954

Note: Coordinates in WGS84, UTM Zone 11

Attachment 1
Overview Map and Detailed Mapbook



Horse Heaven Wind Project
SCOUT CLEAN ENERGY
Overview Map
Turbine Layout Option 1
BENTON COUNTY, WA
Project Lease Boundary
Option 1 Turbine Layout
230 kV Intertie Transmission Line
County Well Road 500 kV Transmission Line
Solar Intertie 500 kV Transmission Line
County Well Road 500-kV Transmission
Project Substation
BPA Substation
Solar Array
Solar Siting Area
Laydown Yard
Radar Tower
Features Removed from Current Design
TETRA TECH
Reference Map
Canada
Washington
Oregon
HH-West Intermediate Substation
HH-West Step-up Substation 500 kV
BPA Webber Canyon Substation
HH West Substation
BPA Bofer Canyon Substation
HH-East Substation
Richland
West Richland
Benton City
Kiona
Chaffee
Badger
Kennewick
Pasco
Richland Junction
West Highlands
South Highlands
Hedges
Finley
Highland
Ainsworth Junction
Burbank
Horse Heaven Hills
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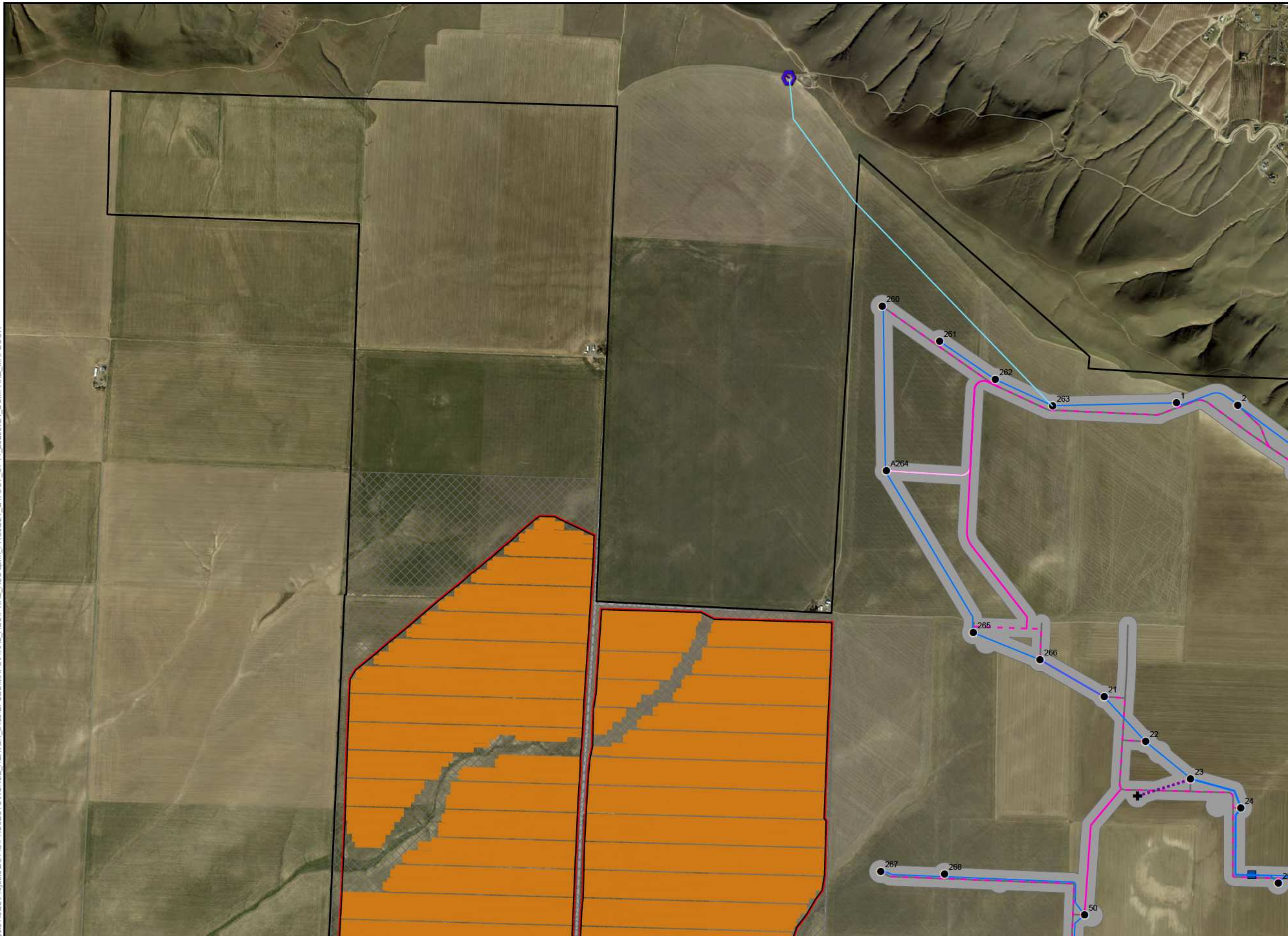
NOT FOR CONSTRUCTION



Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Facility Infrastructure Comparison Turbine Layout Option 1

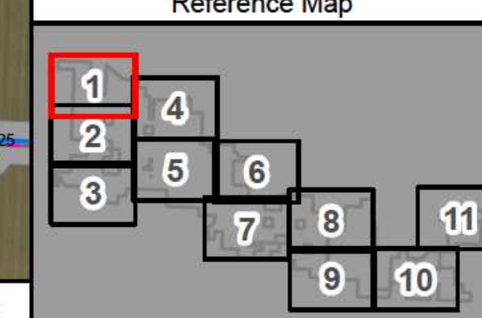
Map 1 of 11

BENTON COUNTY, WA

- Project Lease Boundary
- Wind Energy Micrositing Corridor
- Solar Siting Area
- Option 1 Turbine Layout
- Met Tower
- Met Tower Access Road
- Radar Tower
- Radar Tower Collection Line
- Radar Tower Access Road
- Solar Array
- Solar Array Fencing
- Solar Array Road
- Junction Box
- Collection Line
- CraneCL
- CraneCL_Alt
- CraneCL_OnRoad
- RoadCL
- RoadCL_Alt

TETRA TECH

Reference Map



1:24,000 WGS 1984 UTM Zone 11N

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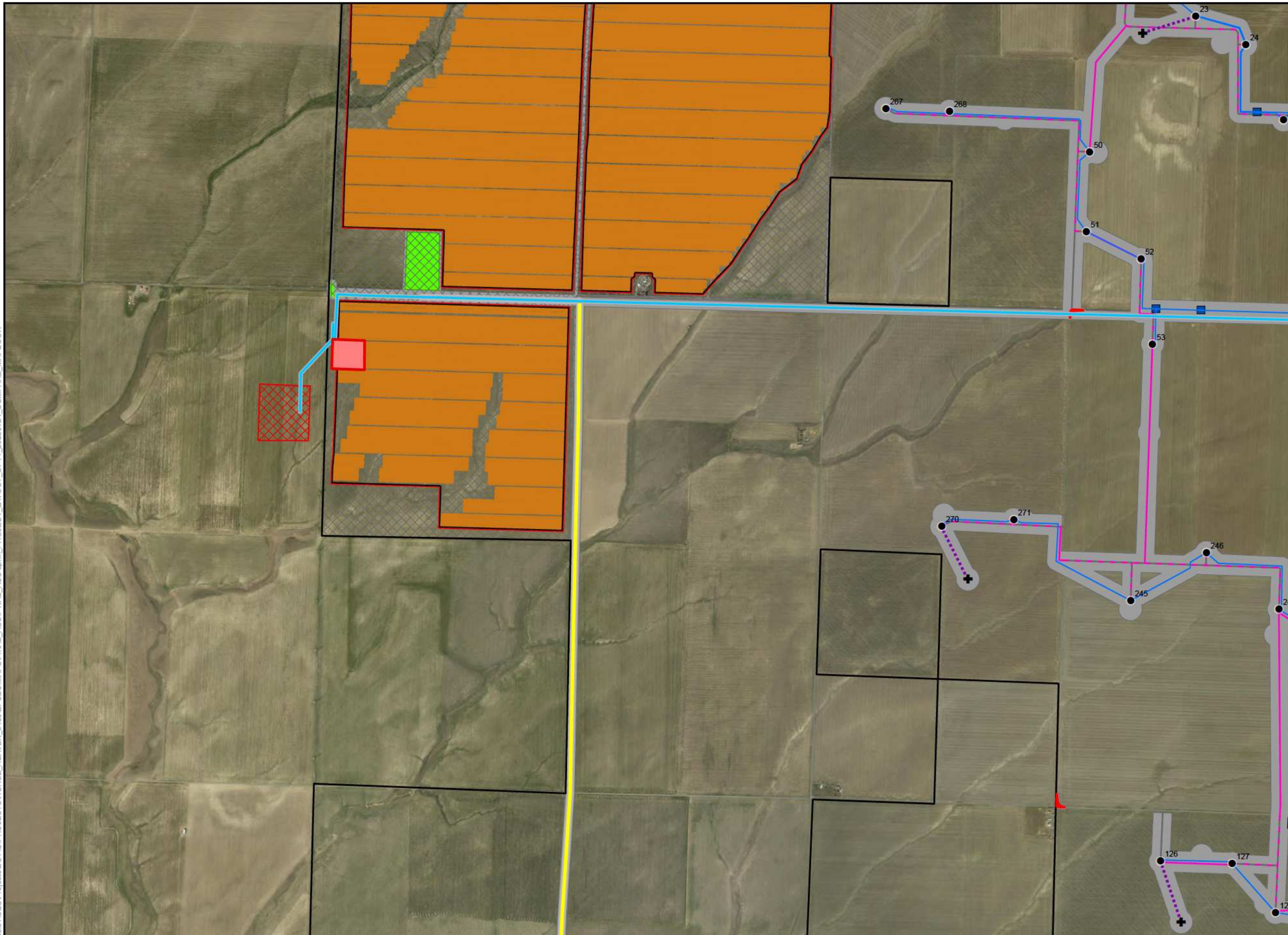


Horse Heaven Wind Project

SCOUT CLEAN ENERGY

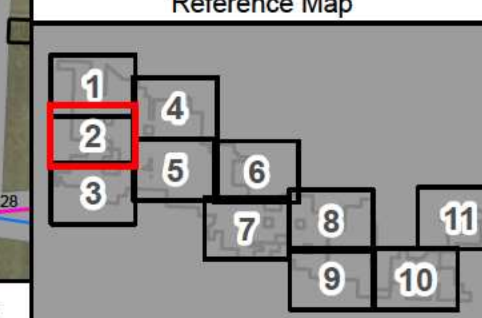
Facility Infrastructure Comparison
Turbine Layout Option 1
Map 2 of 11

BENTON COUNTY, WA

- Features Removed from Current Design
- Project Lease Boundary
- Wind Energy Micrositing Corridor
- Solar Siting Area
- Option 1 Turbine Layout
- Met Tower
- Met Tower Access Road
- County Well Road 500-kV Transmission Line
- Solar Intertie 500-kV Transmission Line
- Intersection Improvement Area
- Project Substation/BESS
- BPA Substation
- Solar Array
- Solar Array Fencing
- Solar Array Road
- Junction Box
- Collection Line
- CraneCL
- CraneCL_OnRoad
- RoadCL

TETRA TECH

Reference Map



1:24,000 WGS 1984 UTM Zone 11N

0 0.25 0.5 1 1.5 2 Miles

NOT FOR CONSTRUCTION

Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Facility Infrastructure Comparison Turbine Layout Option 1

Map 3 of 11

BENTON COUNTY, WA

- Features Removed from Current Design
- Project Lease Boundary
- Wind Energy Micrositing Corridor
- Solar Siting Area
- Option 1 Turbine Layout
- Met Tower
- Met Tower Access Road
- Solar Intertie 500-kV Transmission Line
- Solar Array
- Solar Array Fencing
- Solar Array Road
- Collection Line
- CraneCL
- CraneCL_OnRoad
- RoadCL

TETRA TECH

Reference Map

Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Facility Infrastructure Comparison Turbine Layout Option 1

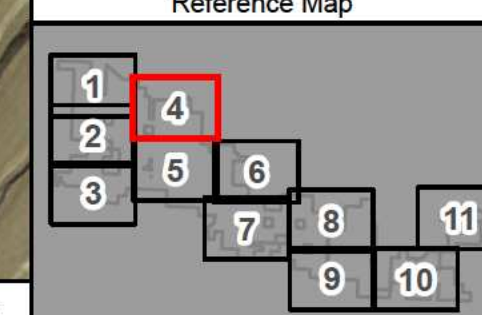
Map 4 of 11

BENTON COUNTY, WA

- Features Removed from Current Design
- Project Lease Boundary
- Wind Energy Micrositing Corridor
- Option 1 Turbine Layout
- 230-kV Intertie Transmission Line
- County Well Road 500-kV Transmission Line
- Intersection Improvement Area
- Project Substation
- Junction Box
- Collection Line
- CraneCL
- CraneCL_OnRoad
- CraneCL_OnRoad_Alt
- RoadCL
- RoadCL_Alt

TETRA TECH

Reference Map



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0 0.25 0.5 1 1.5 2 Miles

NOT FOR CONSTRUCTION

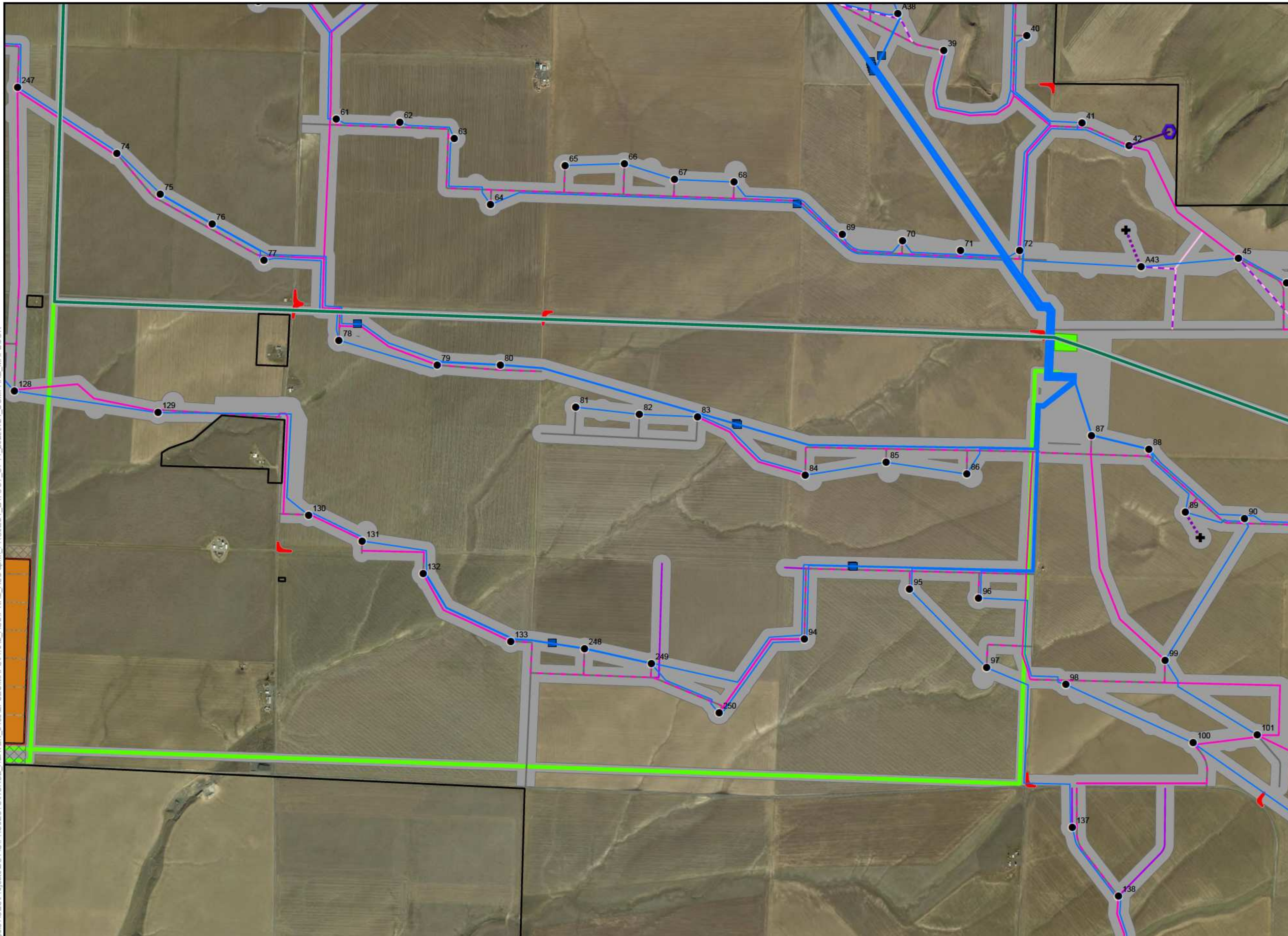
Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Facility Infrastructure Comparison Turbine Layout Option 1

Map 5 of 11

BENTON COUNTY, WA



- Features Removed from Current Design
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- Met Tower
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- Radar Tower
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- Radar Tower Access Road
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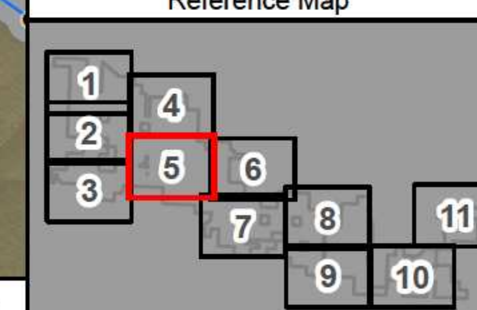
- Solar Array Fencing
- Solar Array Road
- Junction Box
- Collection Line
- CraneCL
- CraneCL_Alt
- CraneCL_OnRoad
- CraneCL_OnRoad_Alt
- RoadCL
- RoadCL_Alt

TETRA TECH

Reference Map



1:24,000 WGS 1984 UTM Zone 11N

0 0.25 0.5 1 1.5 2 Miles

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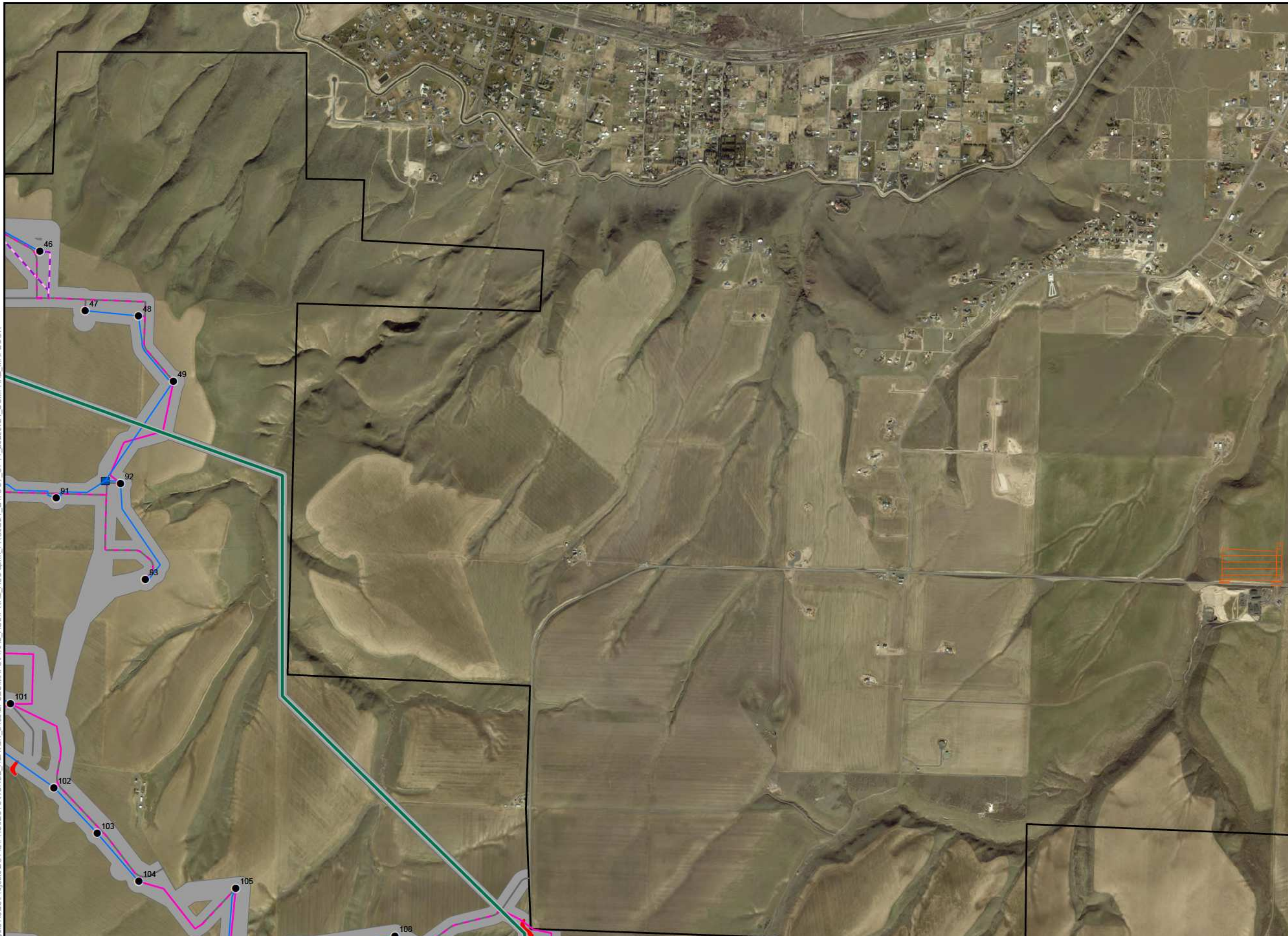
Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Facility Infrastructure Comparison Turbine Layout Option 1

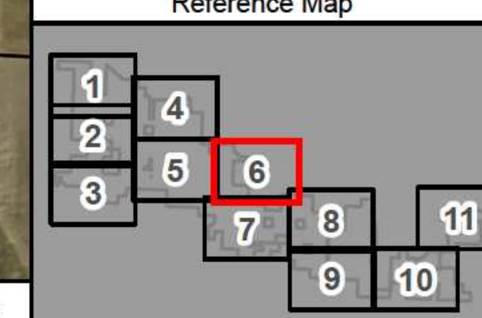
BENTON COUNTY, WA



- Project Lease Boundary
- Wind Energy Micrositing Corridor
- Option 1 Turbine Layout
- 230-kV Intertie Transmission Line
- Intersection Improvement Area
- Laydown Yard
- Junction Box
- Collection Line
- CraneCL
- CraneCL_OnRoad
- CraneCL_OnRoad_Alt
- RoadCL
- RoadCL_Alt

TETRA TECH

Reference Map



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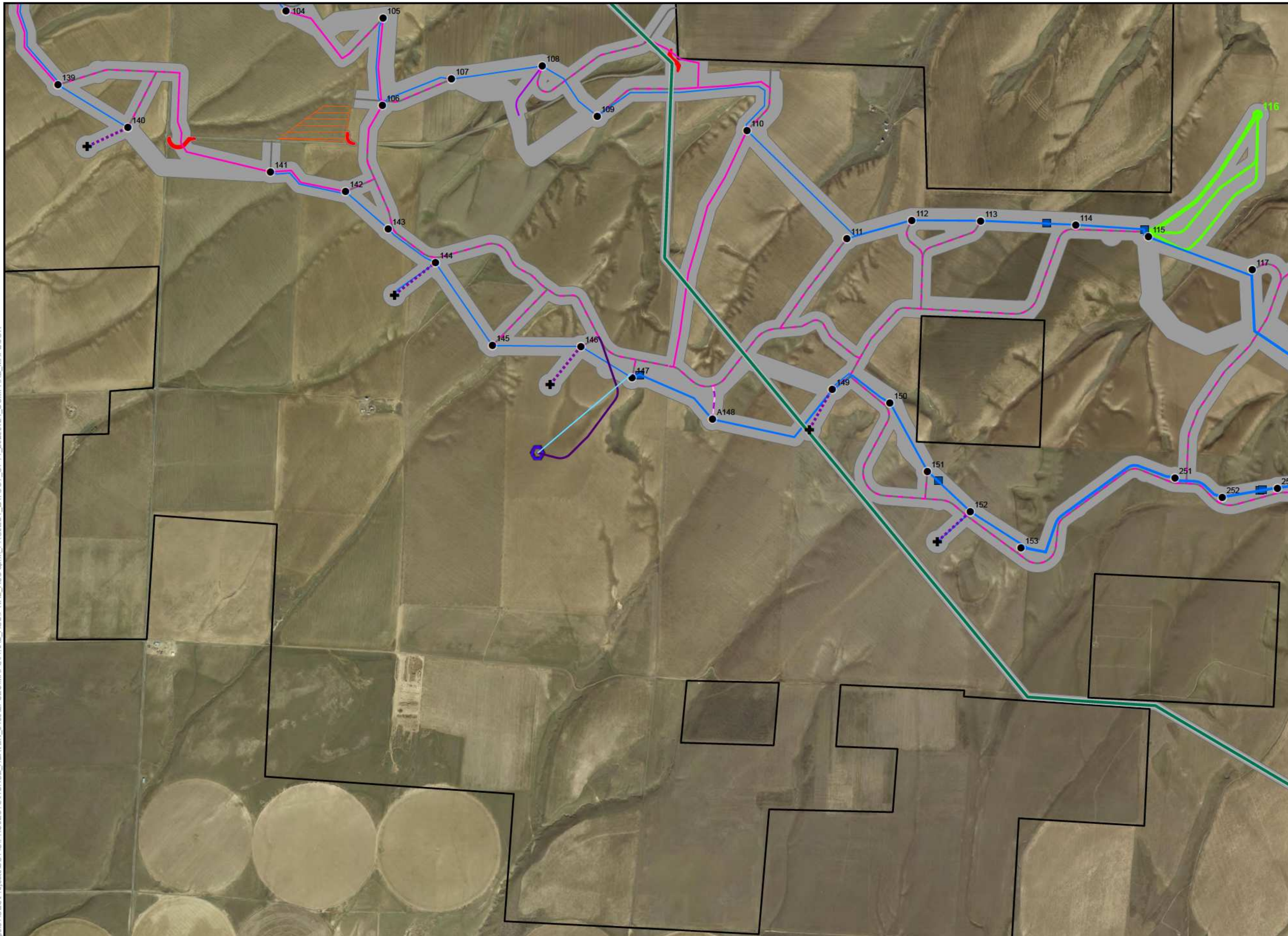

Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Facility Infrastructure Comparison Turbine Layout Option 1

Map 7 of 11

BENTON COUNTY, WA

- Features Removed from Current Design
- Project Lease Boundary
- Wind Energy Micrositing Corridor
- Option 1 Turbine Layout
- Met Tower
- Met Tower Access Road
- Radar Tower
- Radar Tower Collection Line
- Radar Tower Access Road
- 230-kV Intertie Transmission Line
- Intersection Improvement Area
- Laydown Yard
- Junction Box
- Collection Line
- CraneCL
- CraneCL_OnRoad
- CraneCL_OnRoad_Alt
- RoadCL
- RoadCL_Alt

TETRA TECH

Reference Map

1 2 3 4 5 6 7 8 9 10 11

1:24,000 WGS 1984 UTM Zone 11N

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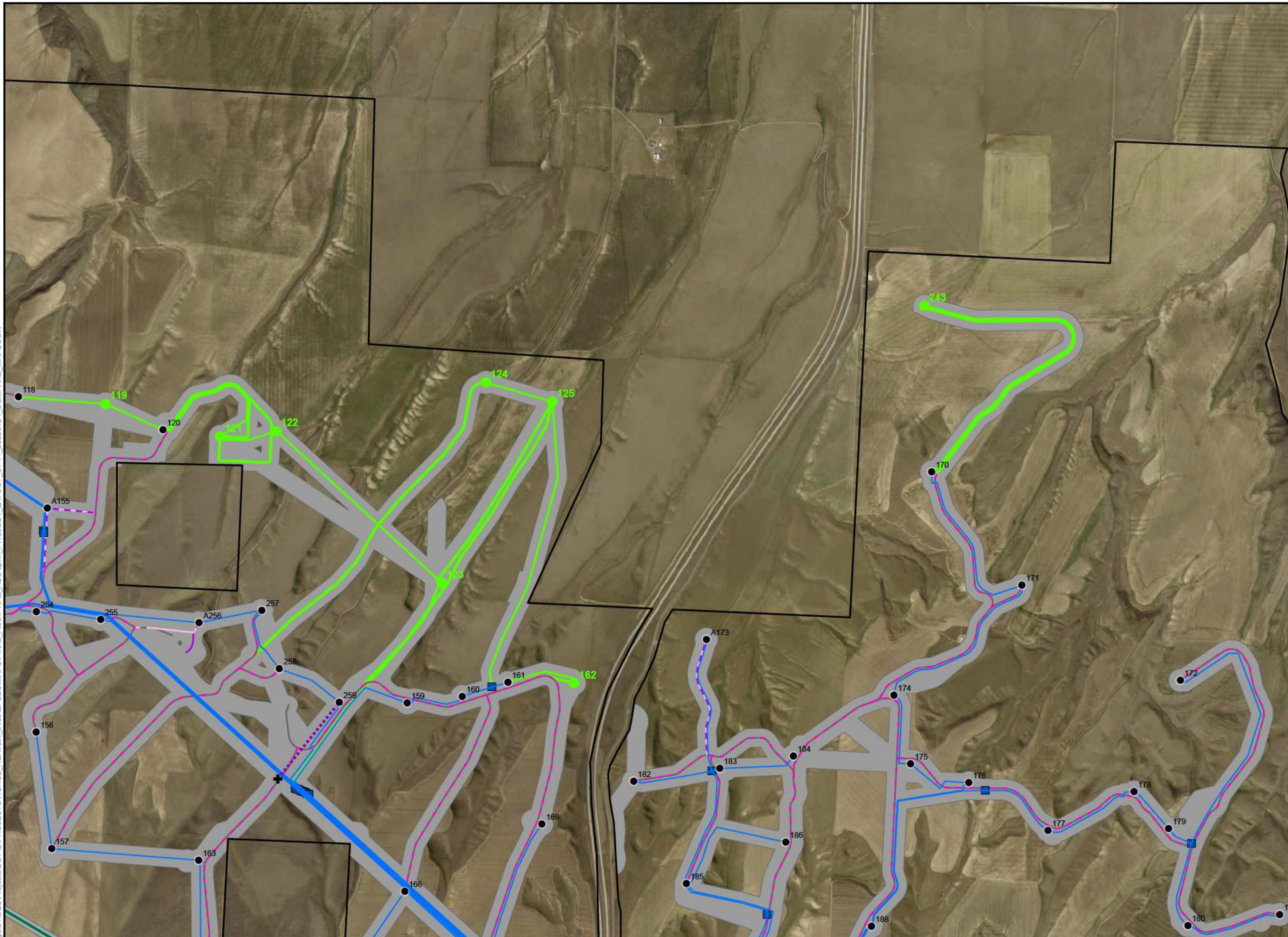

Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Facility Infrastructure Comparison Turbine Layout Option 1

Map 8 of 11

BENTON COUNTY, WA

- Features Removed from Current Design
- Project Lease Boundary
- Wind Energy Micrositing Corridor
- Option 1 Turbine Layout
- Met Tower
- Met Tower Access Road
- 230-kV Intertie Transmission Line
- Junction Box
- Collection Line
- CraneCL_Alt
- CraneCL_OnRoad
- CraneCL_OnRoad_Alt
- RoadCL
- RoadCL_Alt

TETRA TECH

Reference Map

1 2 3 4 5 6 7 8 9 10 11

1:24,000 WGS 1984 UTM Zone 11N

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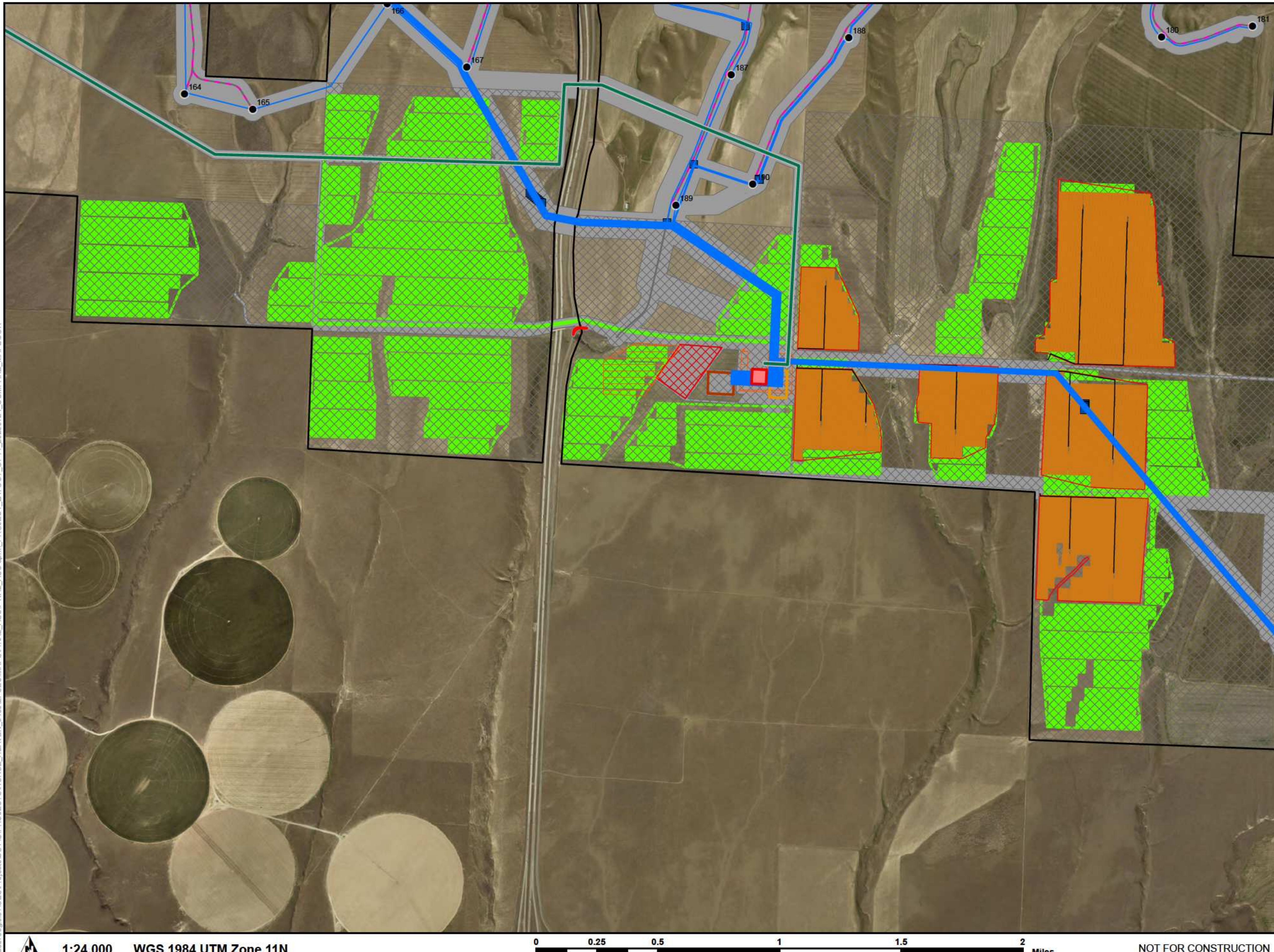


Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Facility Infrastructure Comparison Turbine Layout Option 1

Map 9 of 11

BENTON COUNTY, WA

- Features Removed from Current Design
- Project Lease Boundary
- Wind Energy Micrositing Corridor
- Solar Siting Area
- Option 1 Turbine Layout
- 230-kV Intertie Transmission Line
- Battery Storage
- O & M Facility
- Intersection Improvement Area
- Laydown Yard
- Project Substation
- Solar Array
- Solar Array Fencing
- Solar Array Road
- Junction Box
- Collection Line
- CraneCL_OnRoad
- RoadCL

TETRA TECH

Reference Map

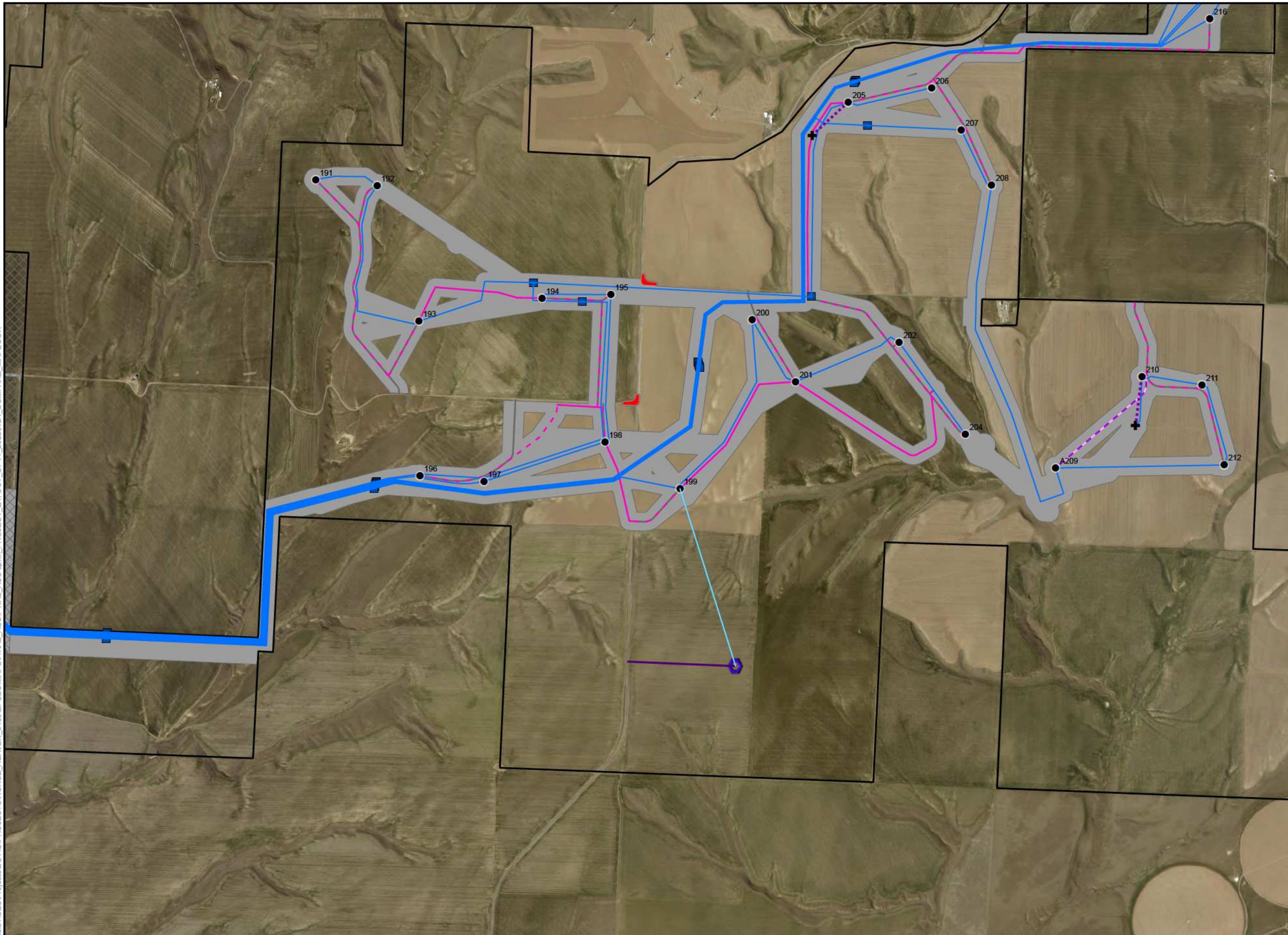
Horse Heaven Wind Project

SCOUT CLEAN ENERGY

Facility Infrastructure Comparison Turbine Layout Option 1

Map 10 of 11

BENTON COUNTY, WA



- Project Lease Boundary
- Wind Energy Micrositing Corridor
- Solar Siting Area
- Option 1 Turbine Layout
- Met Tower
- Met Tower Access Road
- Radar Tower
- Radar Tower Collection Line
- Radar Tower Access Road
- Intersection Improvement Area
- Junction Box
- Collection Line
- CraneCL
- CraneCL_OnRoad
- CraneCL_OnRoad_Alt
- RoadCL
- RoadCL_Alt

TETRA TECH

Reference Map

1 2 3 4 5 6 7 8 9 10 11

1:24,000 WGS 1984 UTM Zone 11N

0 0.25 0.5 1 1.5 2 Miles

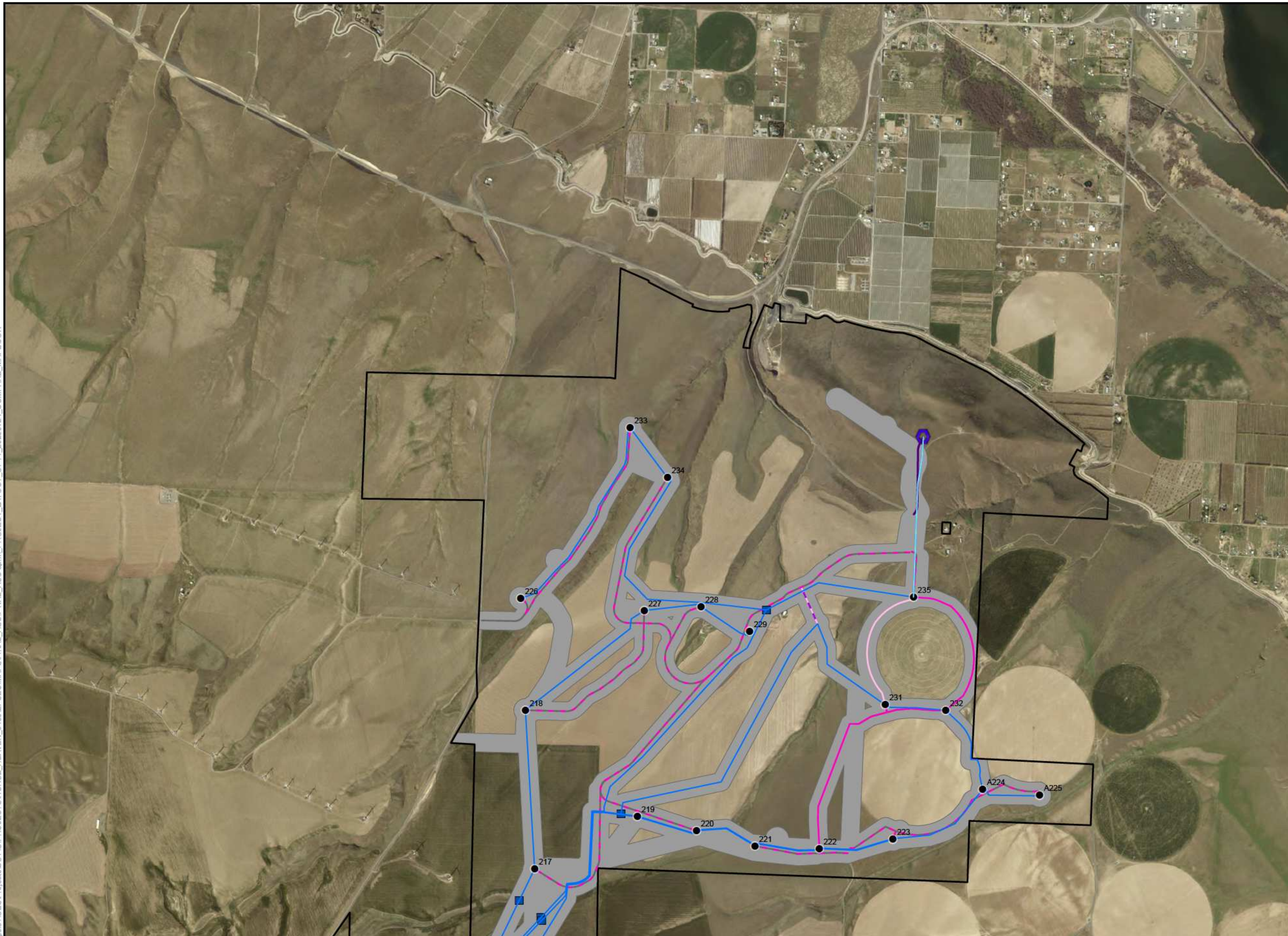
NOT FOR CONSTRUCTION

Horse Heaven Wind Project

Facility Infrastructure Comparison Turbine Layout Option 1

Map 11 of 11

BENTON COUNTY, WA



Project Lease Boundary
Wind Energy Micrositing Corridor
Option 1 Turbine Layout
Radar Tower
Radar Tower Collection Line
Radar Tower Access Road
Junction Box
Collection Line
CraneCL
CraneCL_Alt
CraneCL_OnRoad
CraneCL_OnRoad_Alt
RoadCL
RoadCL_Alt

TETRA TECH

Reference Map

1 2 3 4 5 6 7 8 9 10 11

1:24,000 WGS 1984 UTM Zone 11N

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Attachment 2
ADLS Radar Tower Specifications

Performance Assessment of the DeTect™ HARRIER® X-Band Aircraft Detection Lighting System (ADLS)

James Patterson, Jr.

July 2018

DOT/FAA/TC-TN17/58

This document is available to the U.S. public through the National Technical Information Services (NTIS), Springfield, Virginia 22161.

This document is also available from the Federal Aviation Administration William J. Hughes Technical Center at actlibrary.tc.faa.gov.

U.S. Department of Transportation
Federal Aviation Administration

NOTICE

Technical Documentation Page

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Airport Safety R&D Section
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15. Supplementary Notes

Mike DiPilato (FAA Airport Technology Research and Development Branch) and Joe Healey (SRA International, Inc.) provided technical support during this performance assessment.

16. Abstract

Federal Aviation Administration (FAA) Airport Technology Research and Development Branch (ATR) personnel conducted a performance assessment of the X-band radar version of the HARRIER® Aircraft Detection Lighting System (ADLS) developed by DeTect™, Inc. The purpose of this assessment was to determine if the DeTect HARRIER ADLS meets the ADLS requirements specified in Chapter 14 of FAA Advisory Circular (AC) 70/7460-1L, "Obstruction Marking and Lighting."

FAA ATR personnel assessed a DeTect HARRIER X-band ADLS installed by the Public Service Electric and Gas Company on transmission towers near Aeroflex-Andover Airport (12N), located in Andover, New Jersey. This performance assessment, consisting of demonstrations, flight testing, and data analysis was conducted on June 24, 2016. In the performance assessment, a series of flight patterns were flown against the DeTect HARRIER ADLS to demonstrate whether it could meet the FAA performance requirements specified in AC 70/7460-1L. The DeTect HARRIER X-band ADLS performed according to the manufacturer's specifications and met the performance requirements identified in AC 70/7460-1L.

17. Key Words

Aircraft detection lighting system (ADLS), Obstruction light control, Obstruction lighting, DeTect™ HARRIER

18. Distribution Statement

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Unclassified	Unclassified	53	

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LIST OF ACRONYMS

12N	Aeroflex-Andover Airport
AC	Advisory Circular
ADLS	Aircraft detection lighting system
AGL	Above ground level
ATR	Airport Technology Research and Development Branch
CFR	Code of Federal Regulations
CMMS	Computerized maintenance management system
DCU	Drive control unit
DEWA	Delaware Water Gap National Recreation Area
FAA	Federal Aviation Administration
FCC	Federal Communications Commission
GPS	Global positioning system
HSR	HARRIER® Surveillance Radar
IGIN-EFS	Intelligent Grid Interface Node-Enterprise to Field System®
NM	Nautical mile
PSE&G	Public Service Electric and Gas Company
SCADA	Supervisory control and data acquisition
SQL	Structured query language
U.S.	United States

EXECUTIVE SUMMARY

Federal Aviation Administration (FAA) Airport Technology Research and Development Branch (ATR) personnel conducted a performance assessment of the X-band radar version of the HARRIER® Aircraft Detection Lighting System (ADLS) developed by DeTect™, Inc. The purpose of this assessment was to determine if the X-band DeTect HARRIER ADLS meets the ADLS requirements specified in Chapter 14 of FAA Advisory Circular (AC) 70/7460-1L, "Obstruction Marking and Lighting."

ADLSs continuously monitor the airspace around an obstruction or group of obstructions for aircraft. When the ADLS detects an aircraft in its airspace, the system sends an electronic signal to the lighting control unit, which turns on the lights. Once the aircraft clears the obstruction area and there is no longer a risk of collision, the ADLS turns off the lights, and the system returns to standby mode.

The United States has experienced a steady increase in the number of applications for construction of telecommunication towers and wind turbines. Any temporary or permanent structure, including telecommunication towers and wind turbines, that exceeds an overall height of 200 feet (61 meters) above ground level or exceeds any obstruction standard contained in Title 14 Code of Federal Regulations Part 77, "Safe, Efficient Use, and Preservation of the Navigable Airspace," should be marked and/or lighted with FAA-approved paint markings or lighting fixtures to ensure that they are visible to pilots at night. Due to the number of existing telecommunication towers and wind turbines, combined with expected future construction, the number of obstructions that have these required lighting fixtures has greatly increased. The light generated by the increased number of fixtures has created a light pollution nuisance to residents living near these obstructions. Using an ADLS could have a positive impact on this problem by limiting the amount of time light fixtures are active while still providing a sufficient level of safety for pilots operating at night in the vicinity of these obstructions.

FAA ATR personnel assessed the DeTect HARRIER X-band system installed by the Public Service Electric and Gas Company on transmission towers near Aeroflex-Andover Airport (12N), located in Andover, New Jersey. This performance assessment, consisting of demonstrations, flight testing, and data analysis was conducted on June 24, 2016. In the performance assessment, a series of flight patterns were flown against the DeTect HARRIER system to demonstrate whether it could meet the FAA performance requirements specified in AC 70/7460-1L. The DeTect HARRIER X-band system performed according to the manufacturer's specifications and met the performance requirements identified in Chapter 14 of AC 70/7460-1L.

INTRODUCTION

PURPOSE.

Federal Aviation Administration (FAA) Airport Technology Research and Development Branch (ATR) personnel conducted a performance assessment of the X-band radar version of the HARRIER® aircraft detection lighting system (ADLS) developed by DeTect™, Inc. The purpose of this assessment was to determine if the X-band Harrier ADLS meets the ADLS requirements specified in Chapter 14 of FAA Advisory Circular (AC) 70/7460-1L, "Obstruction Marking and Lighting." [1]

BACKGROUND.

In recent years, several companies have developed ADLSs that monitor the airspace around an obstruction or group of obstructions to automatically turn the obstruction lighting on or off as needed. Such systems continuously monitor the airspace around their location. When the ADLS detects an aircraft in its airspace, the system sends an electronic signal to the lighting control unit, which turns on the lights. Once the aircraft clears the obstruction area and there is no longer a risk of collision, the ADLS turns the lights off and the system returns to standby mode. These ADLSs are typically (1) mounted directly on the obstruction, (2) positioned on a dedicated tower close to the obstruction, or (3) mounted on a stand-alone structure located in the vicinity of the obstruction at an optimized vantage point to ensure that the sensor can cover the entire volume of airspace around the obstruction. In addition to controlling the obstruction lighting, some vendors have suggested using supplemental warning tools, such as an audible warning message or supplemental lighting, thereby providing an additional warning to the pilots that they are operating in close proximity to an obstruction.

The United States (U.S.) has experienced a steady increase in the number of applications for construction of telecommunication towers and wind turbines, partially because of government mandates to improve the nation's emergency communication network and to increase the amount of renewable energy generation. These telecommunication towers and wind turbines have become prominent throughout the U.S. Projections show that the accelerated rate of construction will continue well into the next decade. Any temporary or permanent structure, including these telecommunication towers and wind turbines that exceeds an overall height of 200 feet (ft) (61 meters (m)) above ground level (AGL) or exceeds any obstruction standard contained in Title 14 Code of Federal Regulations (CFR) Part 77, "Safe, Efficient Use, and Preservation of the Navigable Airspace," [2] should be marked and/or lighted with FAA-approved paint markings or lighting fixtures to ensure that they are visible to pilots. Due to the number of existing telecommunication towers and wind turbines, combined with the expected construction of new structures, the number of obstructions that have FAA-required light fixtures has greatly increased. As a result, the increased number of light fixtures has created a light pollution nuisance to residents living near these obstructions. Using an ADLS could mitigate this problem while still providing a sufficient level of safety for pilots operating at night in the vicinity of these obstructions.

From 2011 to 2016, ATR personnel have worked closely with several ADLS vendors to better understand the technologies, capabilities, and performance level that would be necessary to safely integrate this concept into the National Airspace System. One major milestone achieved during the development of the ADLS standards was to enable the sensors to detect aircraft beyond the required 3 nautical miles (NM) from the obstruction. This would ensure that the lighting was on and the pilot was able to visually acquire the lights 3 NM away from the obstruction. The 3-NM visibility requirement is important because it ties directly to the inflight visibility requirements for a flight conducted under Visual Flight Rules. In 2013, ATR personnel first developed ADLS standards based on technical reviews, discussions, and ADLS flight tests in the U.S. and Canada. The FAA has since used these ATR-developed standards as the baseline against which new ADLSs, such as the HARRIER ADLS, were tested. The ATR-developed standards have since been integrated into AC 70/7460-1L as Chapter 14, "Aircraft Detection Lighting Systems," which was published in December 2015 [1].

OBJECTIVES.

The overall objective of this assessment was to conduct a performance assessment of the HARRIER ADLS according to the requirements and standards for ADLSs in Chapter 14 of AC 70/7460-1L [1]. This technical note describes the performance assessment of the HARRIER ADLS installed and owned by the Public Service Electric and Gas Company (PSE&G) near Aeroflex-Andover Airport (12N) in Andover, New Jersey.

THE ADLS STANDARDS

Based on the result of research efforts conducted by FAA ATR personnel, Chapter 14 of AC 70/7460-1L is the first fully comprehensive set of standards for ADLSs published worldwide [1]. Earlier research efforts in Canada and the U.S. led to the development of a few sets of very ambiguous, vague descriptions of the technology, but they did not provide any specific guidance on the required range, coverage area, detection target size, or operational requirements. The following key ADLS operational requirements are introduced in Chapter 14 of AC 70/7460-1L [1]. Chapter 14, in its entirety, is included in appendix A.

1. "The system should be designed with sufficient sensors to provide complete detection coverage for aircraft that enter a three-dimensional volume of airspace, or coverage area, around the obstruction(s) (see figure 1), as follows:

    a. Horizontal detection coverage should provide for obstruction lighting to be activated and illuminated prior to aircraft penetrating the perimeter of the volume, which is a minimum of 3 NM (5.5 km) away from the obstruction or the perimeter of a group of obstructions.

    b. Vertical detection coverage should provide for obstruction lighting to be activated and illuminated prior to aircraft penetrating the volume, which extends from the ground up to 1000 ft (304 m) above the highest part of the obstruction or group of obstructions, for all areas within the 3-NM (5.5-km) perimeter defined in above.

2. The ADLS should activate the obstruction lighting system in sufficient time to allow the lights to illuminate and synchronize to flash simultaneously prior to an aircraft penetrating the volume defined above. The lights should remain on for a specific time period, as follows:

   a. For ADLSs capable of continuously monitoring aircraft while they are within the 3-NM/1000-ft (5.5 km/304 m) volume, the obstruction lights should stay on until the aircraft exits the volume. In the event detection of the aircraft is lost while being continuously monitored within the 3-NM/1000 ft (5.5 km/304 m) volume, the ADLS should initiate a 30-minute timer and keep the obstruction lights on until the timer expires. This should provide the untracked aircraft sufficient time to exit the area and give the ADLS time to reset.

   b. For ADLSs without the capability of monitoring aircraft targets in the 3-NM/1000-ft (5.5-km/304-m) volume, the obstruction lights should stay on for a preset amount of time, calculated as follows:

      i. For single obstructions: 7 minutes.

      ii. For groups of obstructions: (the widest dimension in nautical miles + 6) x 90 seconds equals the number of seconds the light(s) should remain on.

3. In the event of an ADLS component or system failure, the ADLS should automatically turn on all the obstruction lighting and operate in accordance with this AC as if it was not controlled by an ADLS. The obstruction lighting must remain in this state until the ADLS and its components are restored.

   Special Note: As part of the Notice of Proposed Construction or Alteration (FAA Form 7460) filing process, the vendor must provide the FAA with a clear, acceptable explanation of how a component or system failure will be identified and addressed, and must also explain how possible interference will be identified and addressed. A statement such as the following should also be included verifying that the mitigation, monitoring, and fail-safe requirements provided in AC 7460-1L are being met:

   "With regards to system component/system failure and interference of the radar signal, <insert vendor name> incorporates mitigation and monitoring systems which meet the fail-safe requirements for system performance according to FAA AC 70/7460-1L."

4. In the event that an ADLS component failure occurs and an individual obstruction light cannot be controlled by the ADLS, but the rest of the ADLS is functional, that particular obstruction light should automatically turn on and operate in accordance with this AC as if it was not controlled by an ADLS, and the remaining obstruction lights can continue to be controlled by the ADLS. The obstruction lighting will remain in this state until the ADLS and its components are restored.

5. The ADLS's communication and operational status shall be checked at least once every 24 hours to ensure both are operational.

6. Each ADLS installation should maintain a log of activity data for a period of no less than the previous 15 days. This data should include, but not be limited to, the date, time, duration of all system activations/deactivations, track of aircraft activity, maintenance issues, system errors, communication and operational issues, lighting outages/issues, etc." [1]

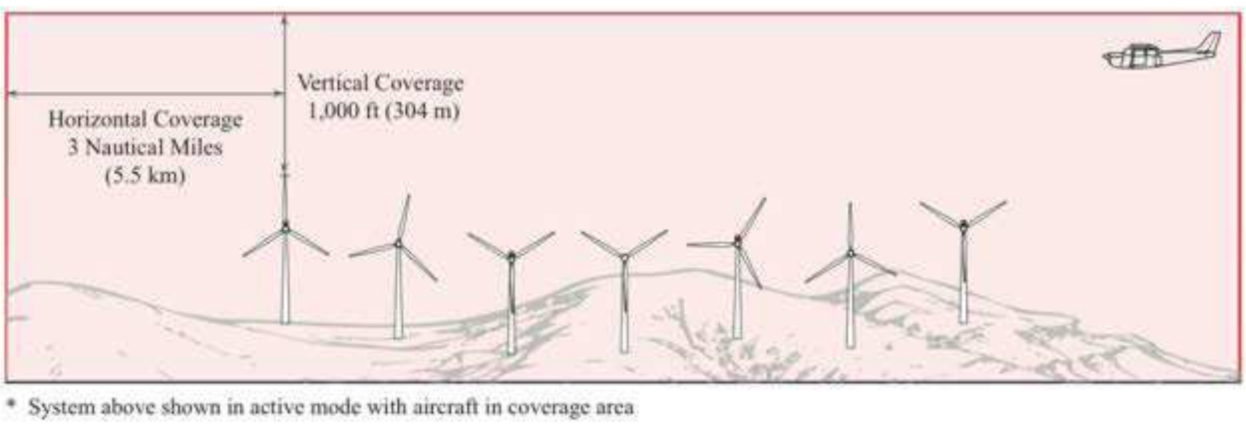


Figure 1. Required ADLS Detection Coverage [1]

Chapter 14 of AC 70/7460-1L also contains language that allows for ADLSs to have an optional voice/audio feature that transmits a low-power, audible warning message over an aviation frequency licensed by the Federal Communications Commission (FCC) in the MULTICOM/UNICOM frequency band to provide pilots additional information on the obstruction they are approaching [1]. The HARRIER ADLS does not offer this option, so these requirements do not apply to this assessment.

HARRIER ADLS CHARACTERISTICS AND SPECIFICATIONS

DeTect ADLS uses the company's surveillance radars to provide automated aircraft tracking and lighting activation for wind farms and other obstruction(s), as described in Chapter 14 of AC 70/7460-1L [1]. The system is designed to connect to and control a supervisory control and data acquisition (SCADA) system at a wind farm or other obstruction(s). The system interfaces with lighting systems to keep obstruction warning lights powered off unless an aircraft is detected in the vicinity of these obstructions. When aircraft are detected within the volume of airspace surrounding the obstruction(s), the obstruction warning lights are activated (turned on). When all aircraft have safely left the volume, the lights are deactivated (turned off). As with other ADLSs, the design of the HARRIER ADLS allows obstruction warning lights to remain off when aircraft are not in the obstruction vicinity. Appendices B and C contain additional information provided by DeTect regarding this system.

The core systems of the HARRIER ADLS are the radar(s) and HARRIER radar controller data system(s). The other components of the complete ADLS installation include a SCADA obstruction lighting control system and computerized maintenance management system (CMMS). Figure 2 shows an example of the HARRIER ADLS installation described later in this technical note with the Intelligent Grid Interface Node Enterprise to Field System® (IGIN-EFS) developed by DigitaLogic, Inc.

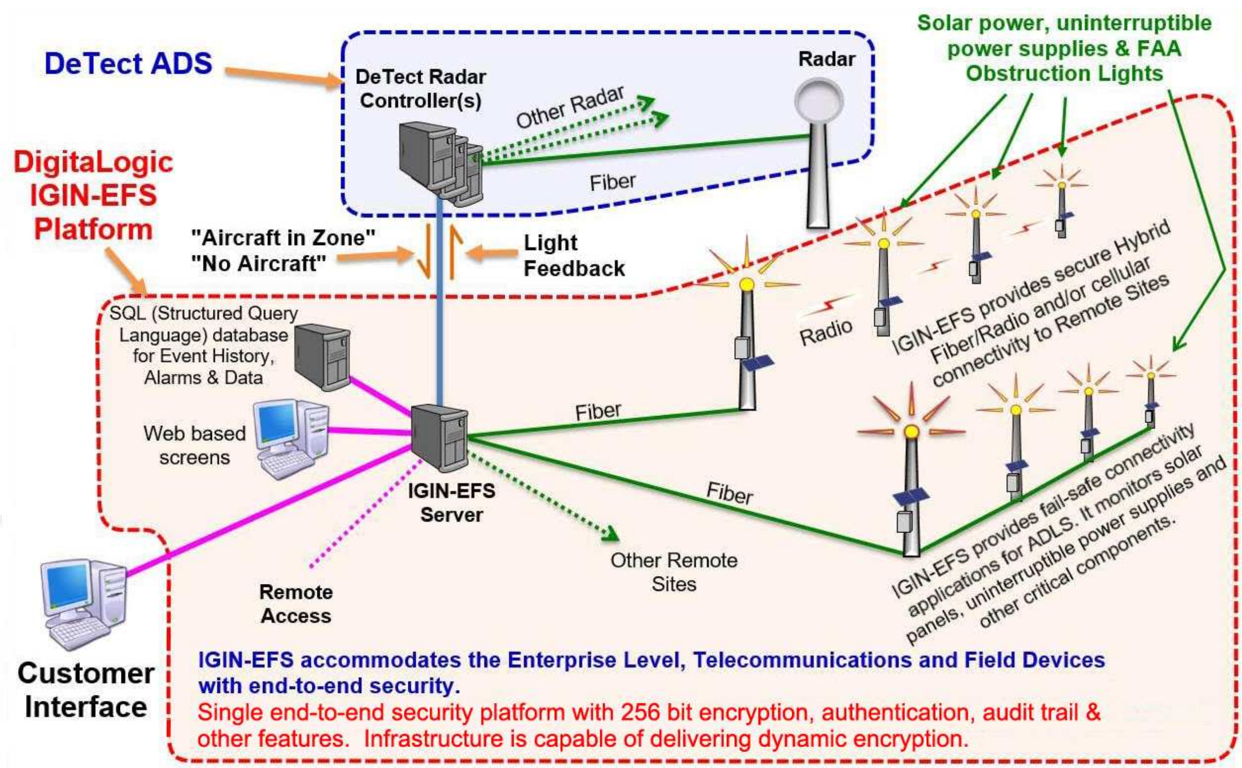


Figure 2. HARRIER ADLS Connected to Other ADLS Components [3]

HARRIER ADLS OPERATIONAL DESCRIPTION.

A simplified diagram of the HARRIER ADLS logic is shown in figure 3. This system follows the general requirements described in AC 70/7460-1L [1]. The HARRIER ADLS operates as follows:

1. The ADLS receives input from the radar(s) and monitors a defined zone around the obstructions (3.5-NM/1000-ft (6.5-km/304-m) volume or greater).

2. When aircraft are detected within the zone, the ADLS sends a signal to the obstruction lighting system, indicating the lights should be turned on.

   a. When the last aircraft is tracked exiting the airspace volume (3.5-NM/1000-ft (6.5-km/304-m) volume) and the aircraft count reaches 0, a 30-second countdown timer is activated.

   b. If radar contact is lost with any aircraft within the monitored airspace volume, a 30-minute countdown timer is activated, and the lights remain on until this countdown expires.

3. When all countdown timers reach 0, the structured query language (SQL) database on the ADLS radar controller data system generates a signal to turn off the obstruction lights.

4. A continuous system operation check is performed. If any components are not operational, the obstruction lights will be activated.

Note: For systems installed with two or more radars, light activation will occur if any of the radar units detects an aircraft.

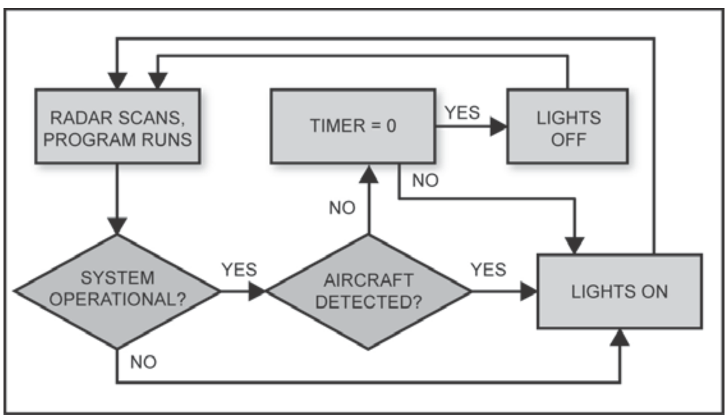


Figure 3. HARRIER ADLS Logic Overview [3]

<u>HARRIER ADLS RADAR DESCRIPTION</u>.

The HARRIER ADLS can use 360-degree, 200-watt solid state S- or X-band Doppler radar sensor(s), which are referred to as HARRIER Surveillance Radars (HSRs) [4]. The HSR assessed by the FAA for this technical note was the X-band version. The HSR is designed to detect noncooperative aircraft in environments with large amounts of radar clutter, such as wind turbine blades at wind farms [4]. Figure 4 shows an example of the X-band version of the HSR with the radome enclosure installed on top of a transmission tower.

Figure 4. DeTect X-Band ADLS Radar With Radome Enclosure

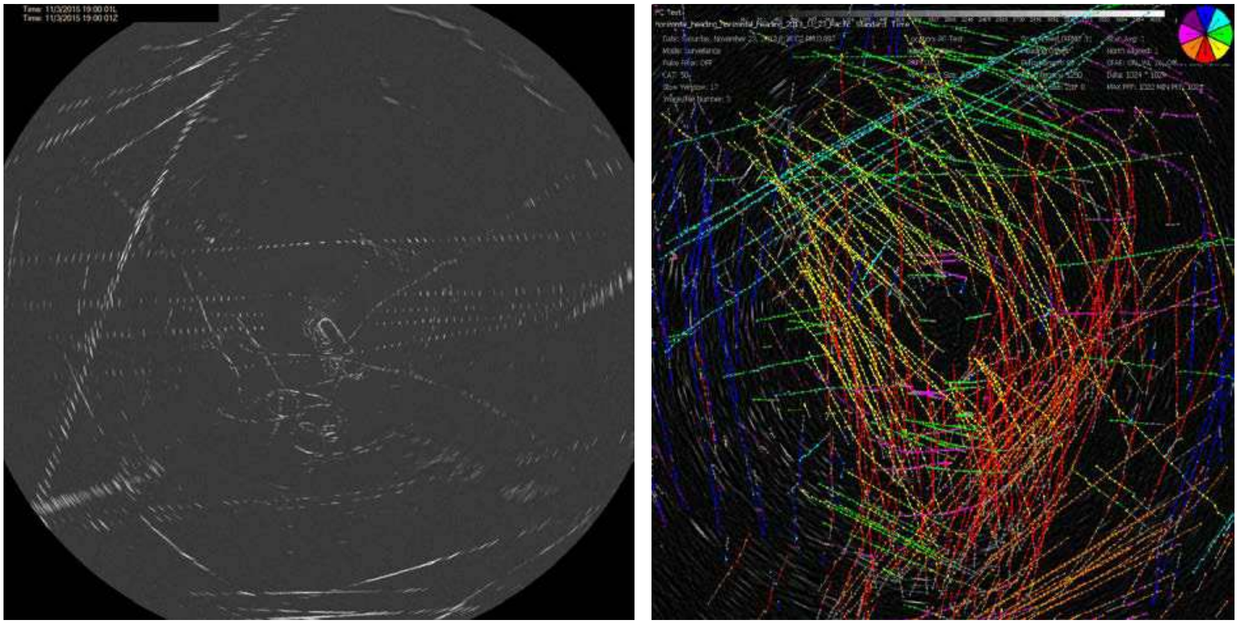
DeTect states that the HSR has a detection range of up to 28 statute miles. The HSR can be set to detect aircraft based on user-defined perimeters (DeTect recommends setting a detection range of up to 10 miles). The system is powered by 110/220 volts of alternating current, 60/30 amperage service with uninterruptable power supply back-up and power conditioning (30 minutes) [4]. DeTect also offers an optional diesel generator to assist ensuring continuous operation.

A required component of the HSR is the drive control unit (DCU). This is typically located at the base of the tower on which the radar is mounted. The DCU maintains a constant power and rate of revolution for the radar. The DCU also converts the signal from the radar into a format that can be sent via optical fibers to the server location for processing and target tracking.

HARRIER ADLS RADAR CONTROLLER DATA SYSTEM DESCRIPTION.

The radar data from the HARRIER ADLS is processed and recorded by servers running a combination of DeTect's proprietary software, known as Merlin®, and Microsoft® SQL Server® database software. The primary function of this system is to track aircraft targets and send signals to the obstruction lighting system indicating when obstruction lights can be turned on or off based on whether there are aircraft within a predefined perimeter around the obstruction.

Figure 5(a) shows a 1-hour, time-lapsed image plot of raw aircraft radar tracks, while figure 5(b) shows radar tracks after being processed by the Merlin software [5]. This software also receives input from the obstruction lighting system regarding the status of these lights. All aircraft track data is recorded to the SQL database, which can be accessed by other monitoring systems, such as CMMS interface [6]. This database also provides a forensic tool in the event of system failure [6].



(a) (b)

Figure 5. Unprocessed Radar Image (a) and Radar Image Processed by HARRIER Server (b) [5]

<u>HARRIER ADLS PERIMETERS</u>.

The HARRIER ADLS data system generates tracks for aircraft within a distance of 9 NM from each of the two radar units (shown as red and blue circles in figure 6). Within these overlapping 9-NM perimeters is a warning zone perimeter surrounding the obstruction(s). When aircraft enters this warning zone perimeter, the lights on the obstruction(s) are activated. The warning zone perimeter radius is set at a distance of 3.5 NM (6.5 km) or more from the obstruction(s). This 3.5-NM distance ensures the lights are activated by the time the aircraft reaches the 3.0-NM (5.5-km) perimeter defined in AC 70/7460-1L [1]. Examples of these perimeters are shown in figure 6.

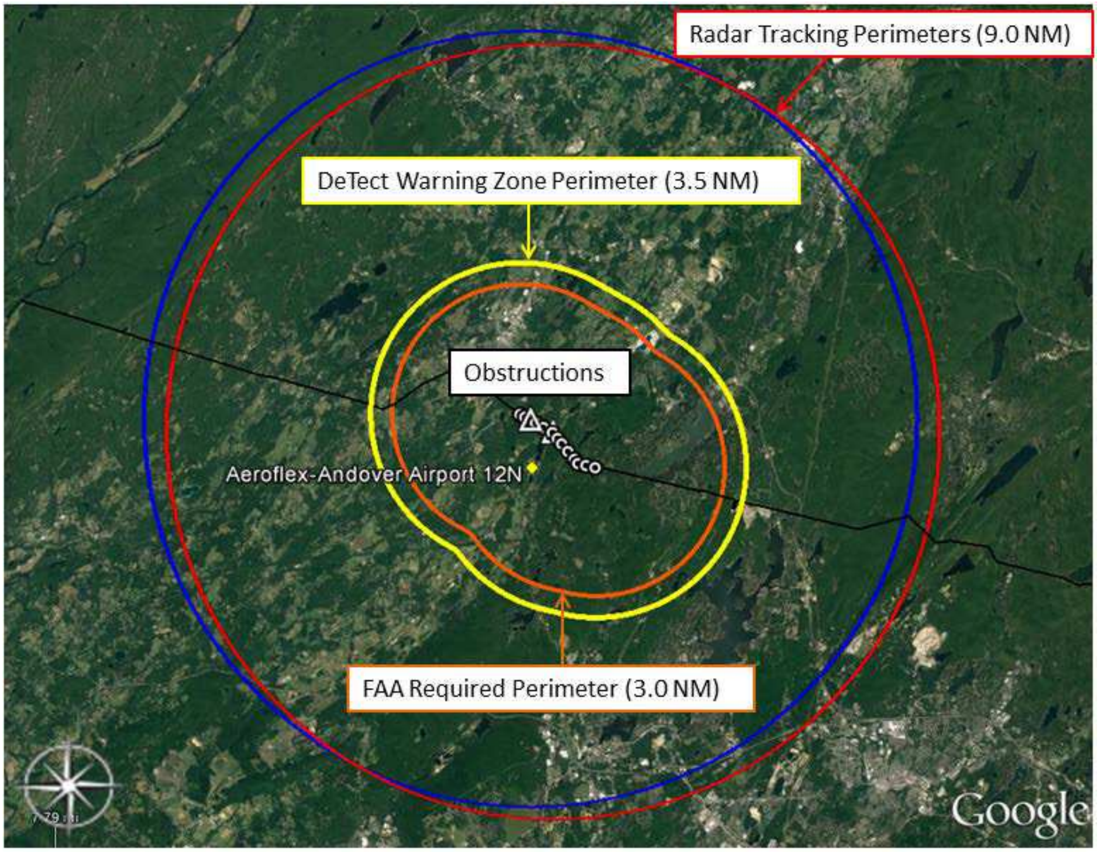


Figure 6. HARRIER ADLS Perimeters

<u>HARRIER ADLS OBSTRUCTION LIGHTING CONTROL SYSTEM DESCRIPTION</u>.

The obstruction lighting control system used by the HARRIER ADLS described in this technical note was the DigitaLogic IGIN-EFS platform. The IGIN-EFS, shown in figure 7, performs the following functions [3]:

- Monitors and controls the obstruction lights.
- Provides fail-safe applications in the event of component or network failure.
- Sends customized data to a CMMS interface.
- Provides 256-bit encryption authentication audit trail and other security features.
- Generates maintenance and status reports on the current health of the system.
- Generates text/email alarm notifications.

The HARRIER ADLS and the IGIN-EFS systems together form the collective ADLS system for the PSE&G installation.

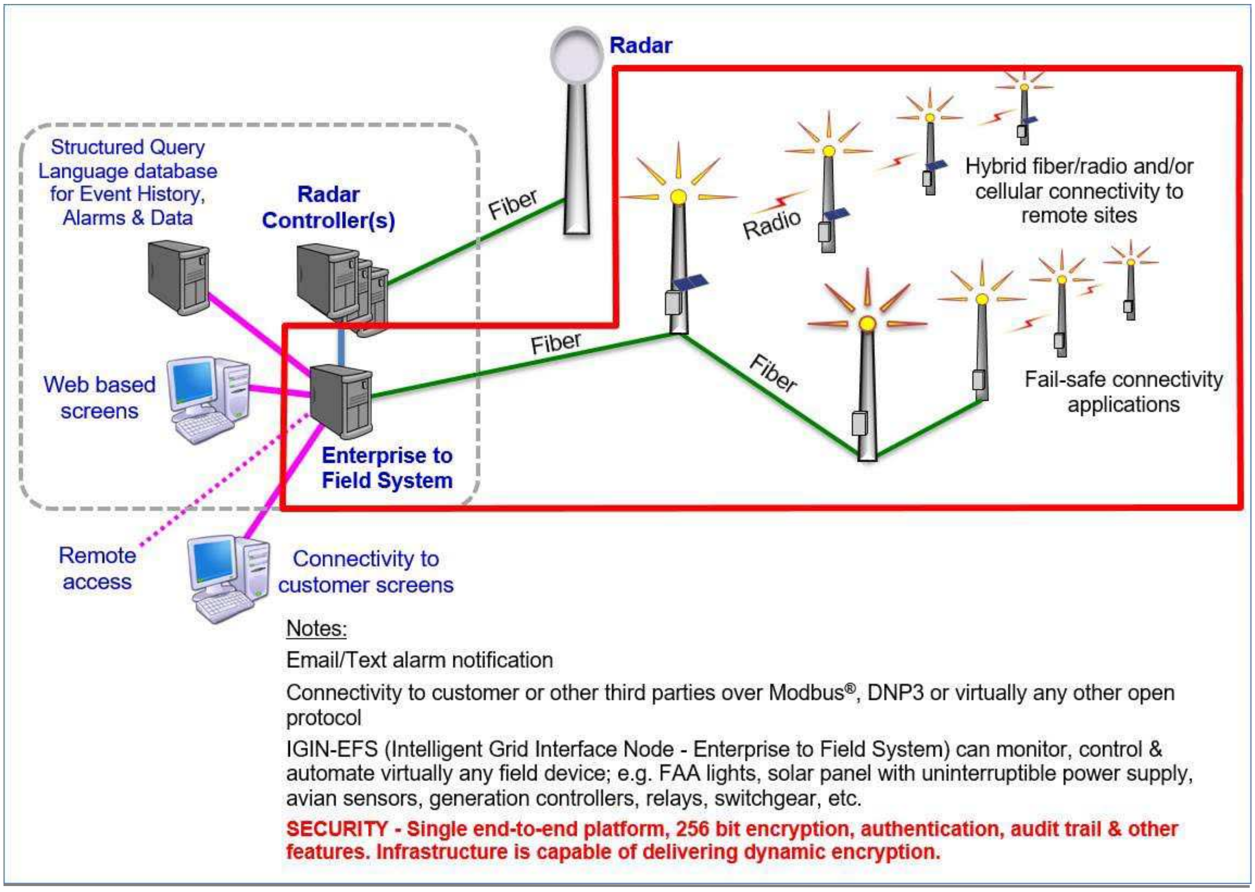


Figure 7. DigitaLogic IGIN-EFS Obstruction Lighting Control System [3]

THE PSE&G ADLS DISPLAY.

After processing, the data from the HARRIER ADLS and DigitaLogic IGIN-EFS can be sent to a consolidated display that allows the owner of the ADLS to monitor the system. The data sent from the HARRIER ADLS can be customized according to the needs of the obstruction owner, showing information such as real-time system health status, aircraft being tracked by the system, and lights-on status of the system. Figure 8 shows the display used by PSE&G for three HARRIER ADLS sites. In this example, the blue circles represent the 3.5-NM (6.5-km) warning zone perimeters for each ADLS site. Aircraft being tracked by the HARRIER ADLS are depicted as red triangles with trailing lines. Color-coded system status indicators are shown on the right side of the screen. The color green indicates systems are functioning normally, while red indicates an issue with the component shown. Also, on the right-hand side of the interface beneath each system status, there are counters showing the number of aircraft currently within each warning zone and the amount of time remaining until the obstruction lights will be turned off by the system.

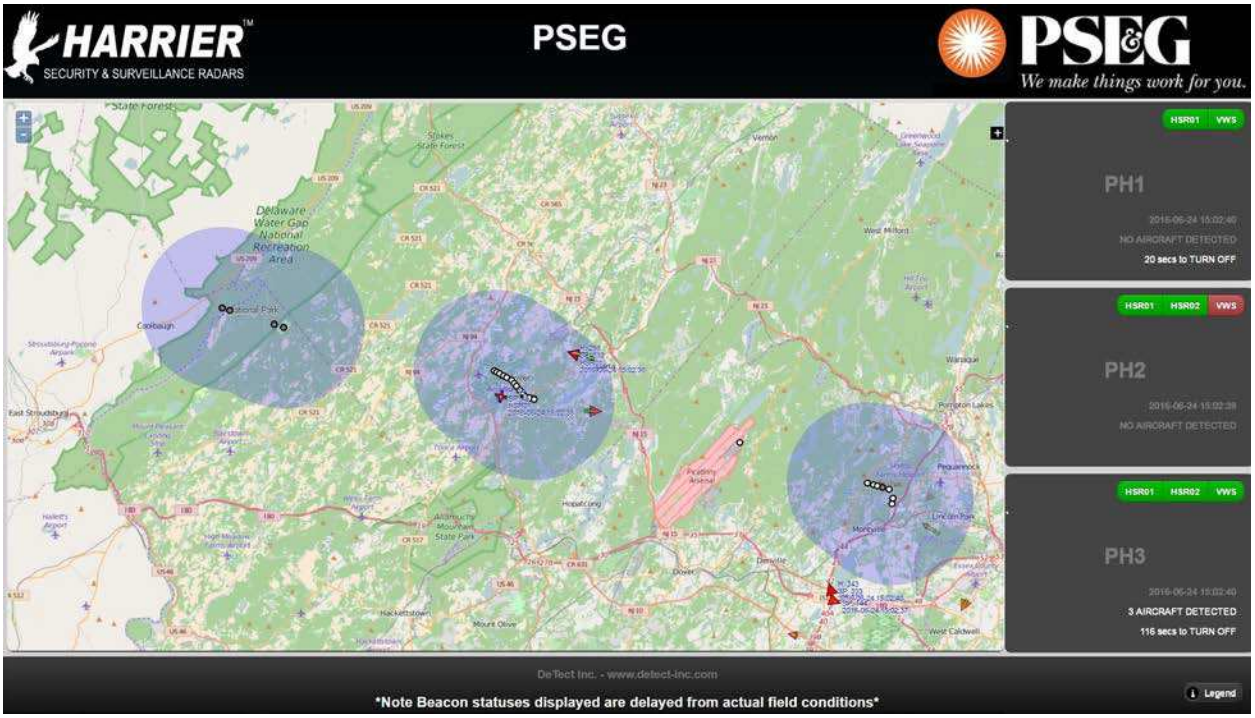


Figure 8. The PSE&G ADLS System Display [6]

<u>HARRIER ADLS FAIL-SAFE DESIGN</u>.

The HARRIER ADLS and IGIN-EFS obstruction lighting control system are designed to provide fail-safe protection to ensure that if any errors or malfunctions occur, the obstruction lights are activated automatically. The lights will remain on until normal function is restored to all system components. The HARRIER ADLS is designed to keep obstruction lights on by default, and only a coordinated effort involving all systems and devices functioning in a normal state will allow the lights to be turned off [3].

The HARRIER ADLS includes system health monitoring, built in fail-safes, and target detection redundancy. The HARRIER ADLS can use two or more radar systems to provide overlapping radar coverage. If all radars lose radar contact with an aircraft within the warning zone, the lights will be activated. If weather is detected in the warning zone that could potentially interfere with system operation, the obstruction lights will be activated [4].

HARRIER ADLS software that runs on the SQL data system independently monitors the HARRIER software “heartbeat” [6]. In addition, HARRIER ADLS records internal processes on the SQL Server and communications between DeTect’s system and DigitaLogic’s lighting control system. DigitaLogic’s IGIN-EFS also independently monitors the HARRIER ADLS heartbeats between the radar controller data system and the DigitaLogic light activation system [3]. The IGIN-EFS will independently keep obstruction lights on if any issues are detected in the HARRIER ADLS and will record information about these events for later review. DeTect’s ADLS servers will send email alerts if there are any issues with the radar and send a daily email letting the owner know the system is online and operational [6].

DETECT SYSTEM INSTALLATION DESCRIPTION NEAR 12N

The HARRIER ADLS assessed in this technical note was installed by PSE&G as part of an ADLS on its 500-kilovolt (kV) Susquehanna-Roseland electrical transmission line. This transmission line runs from Berwick, Pennsylvania to Roseland, New Jersey. To address concerns about excessive lighting from the communities, PSE&G installed DeTect HARRIER ADLS technology at three sites in New Jersey: Delaware Water Gap National Recreation Area (DEWA), near 12N in Andover, New Jersey (referred to herein as the 12N site), and Montville, New Jersey (shown in figure 9) [6].

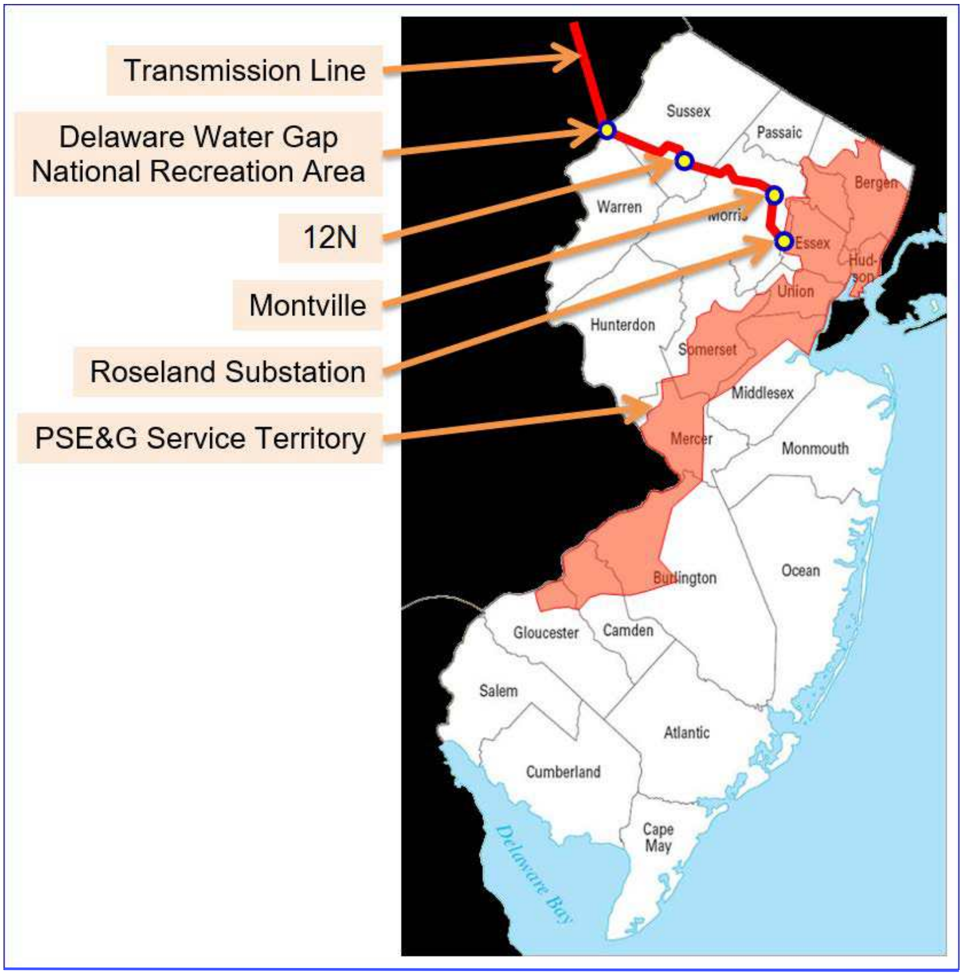


Figure 9. The PSE&G Susquehanna-Roseland Transmission Line [3]

The specific ADLS assessed by the FAA was located at the 12N site, which is shown highlighted with yellow circles in figure 10. The terrain features at the 12N site, which include mountains, ridges, valleys, and lakes, created a challenging environment for the radars. As a result of this complex terrain, two radars were installed at the 12N site to provide adequate coverage.

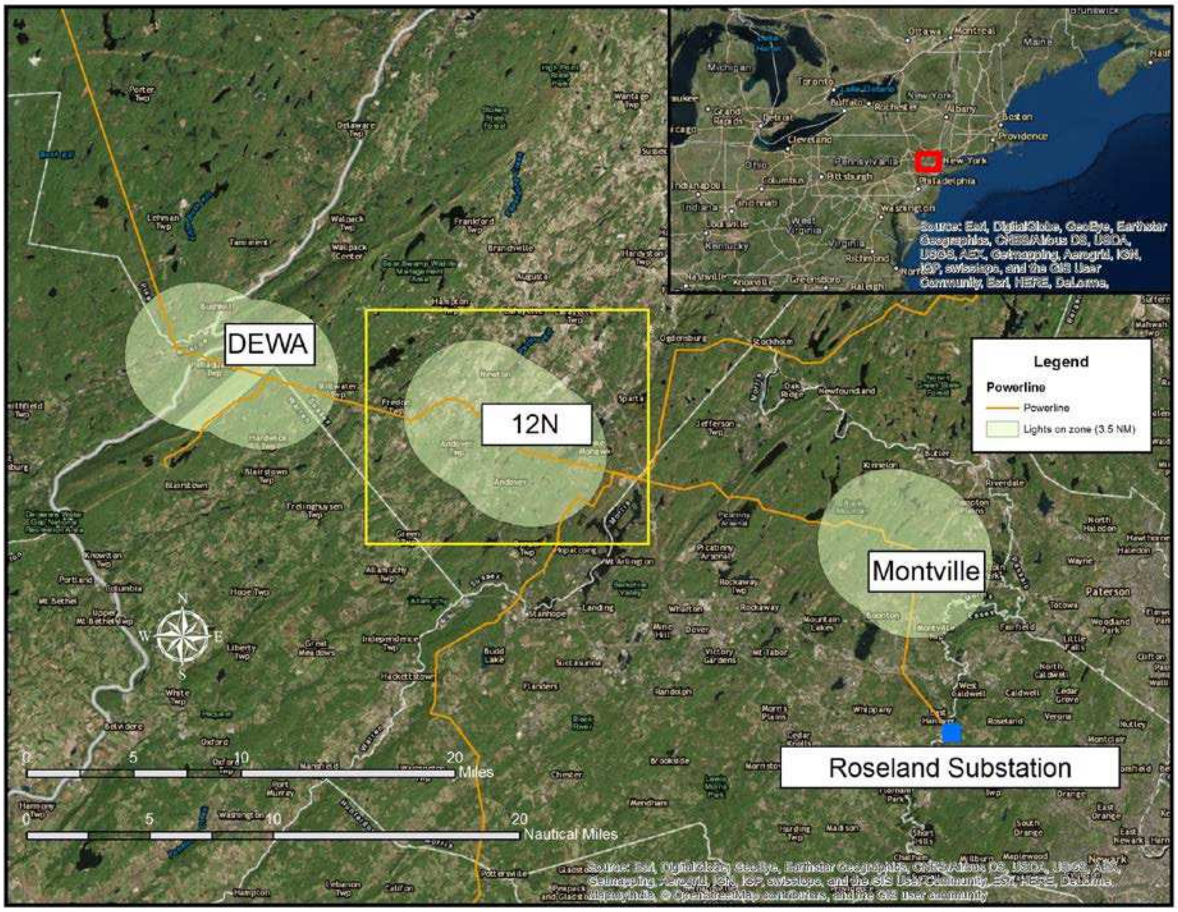


Figure 10. The PSE&G ADLS Installation Sites at DEWA, 12N, and Montville

As shown in figure 11, the servers for the ADLS were located approximately 28 NM from the 12N ADLS site at PSE&G's Roseland substation. The servers communicate with each ADLS site via a fiber-optic network, which is incorporated into the transmission line facility. However, for the performance assessment, PSE&G set up a temporary workstation at 12N for ATR personnel to observe the system's performance.

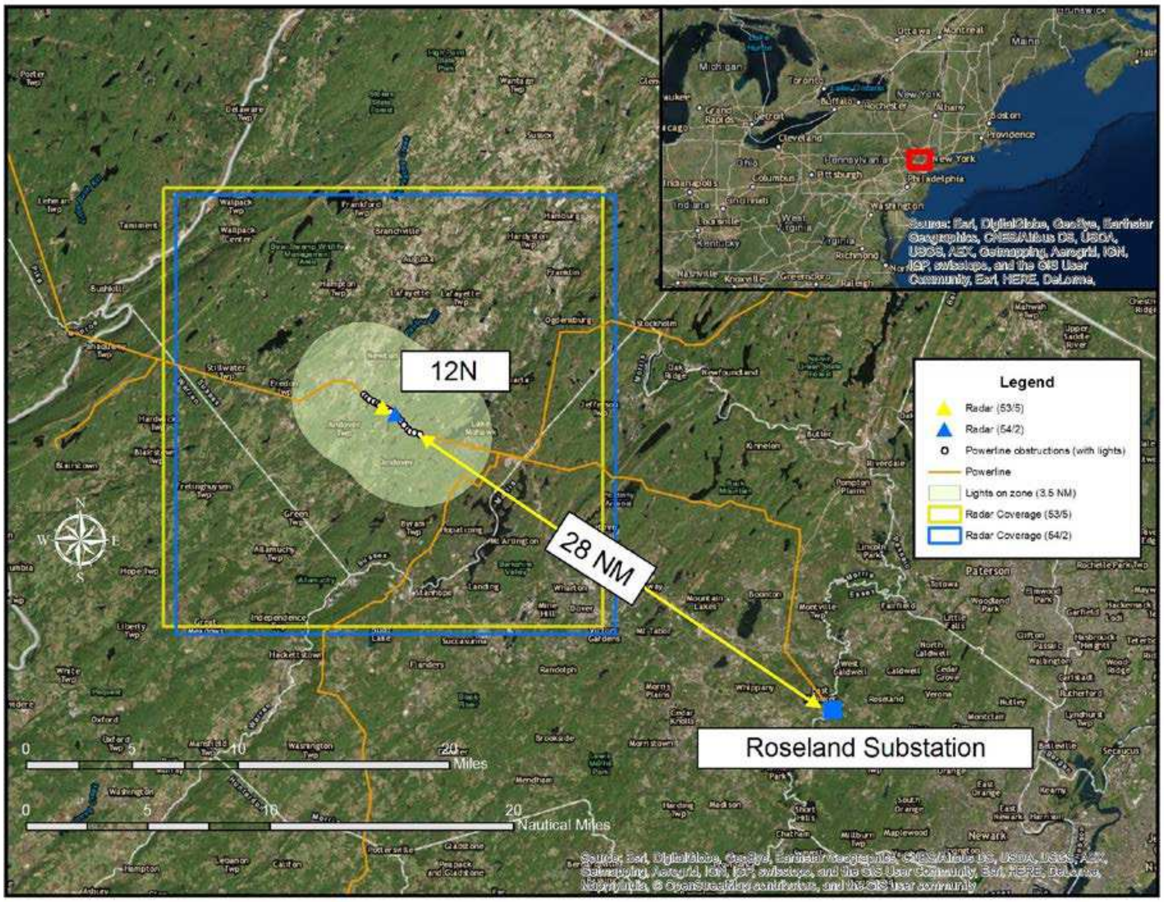


Figure 11. Andover ADLS Site Distance to Roseland Substation

Figure 12 shows an enlarged view of the 12N site and the two transmission towers where the HSRs for the ADLS were positioned. The radar installed on tower 54/2 was designated as HSR-01, and the radar installed on tower 53/5 was designated as HSR-02. Table 1 shows the global positioning system (GPS) coordinates and elevations of these two radar units.

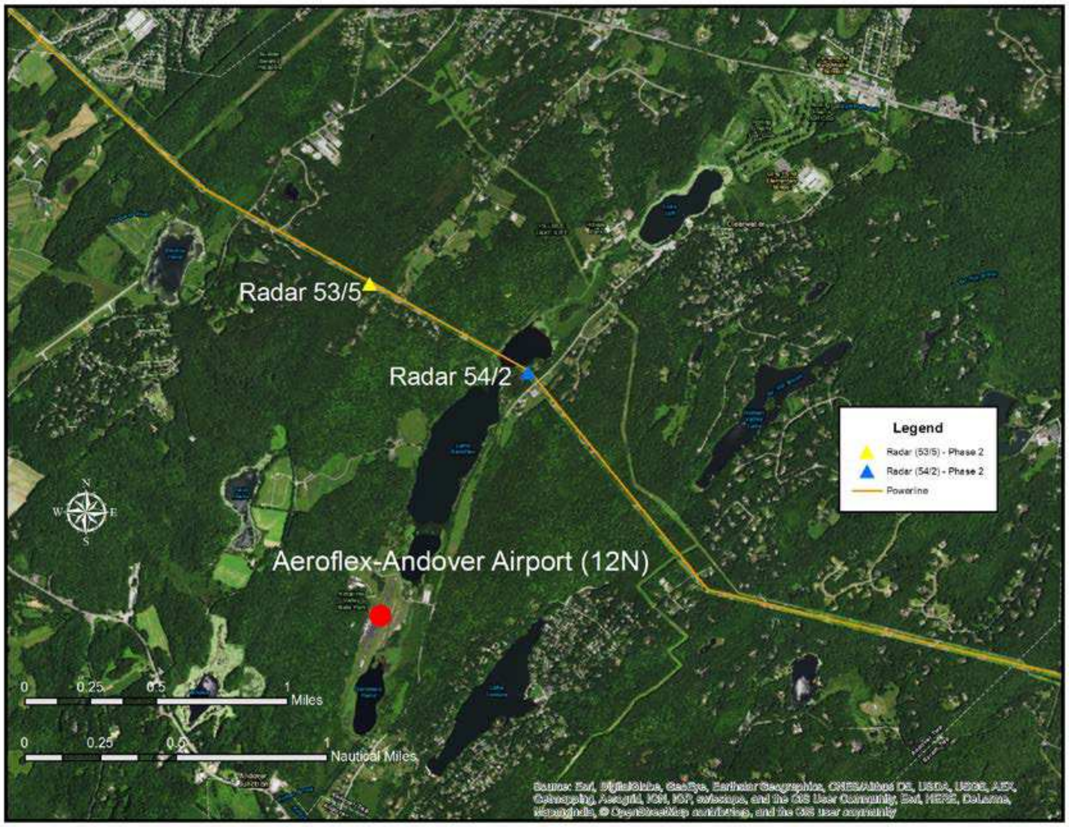


Figure 12. Radar Locations Near 12N

Table 1. The GPS Coordinates of DeTect ADLS Radars Near 12N

Tower Number	Radar Designation	Ground Elevation (MSL)	Installed Height (AGL)	Total Height (MSL)	Latitude	Longitude
54/2	HSR-01	604.860 ft	185 ft	789.862 ft	41° 1'20.68"N	74°43'37.55"W
53/5	HSR-02	724.828 ft	170 ft	894.828 ft	41° 1'38.16"N	74°44'18.79"W

MSL=Mean Sea Level

As shown in figure 13, 12N was located within a short distance of the PSE&G transmission line in the departure and arrival path of aircraft operating from this airport. Therefore, HSR-01 was installed on tower 54/2 to provide direct line of sight to this airport to ensure the lights were activated when aircraft were taking off or landing. Figure 14 shows HSR-02 installed on tower 53/5. This tower was located at an elevation 120 ft higher than HSR-01 to provide additional radar area coverage.

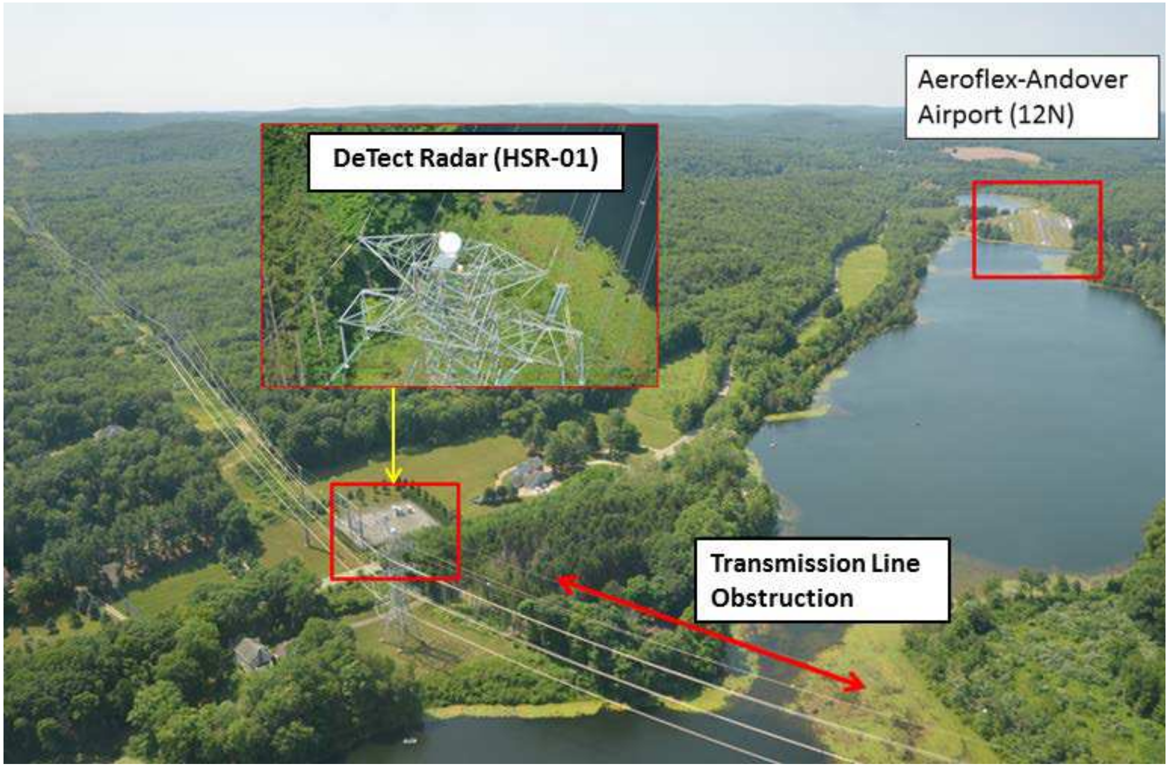


Figure 13. Transmission Line Obstruction in Relation to 12N

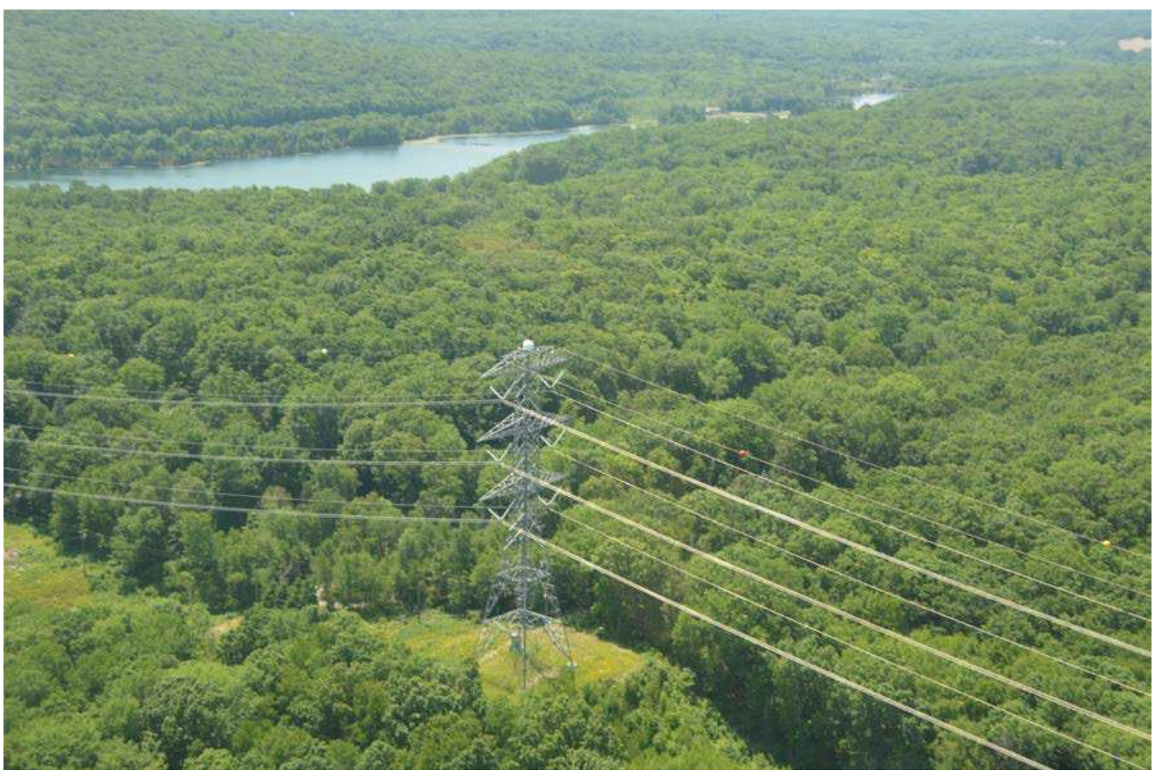


Figure 14. The HSR-02 Installed on Transmission Tower 53/5

Figure 15 shows an example of the DCU equipment located at the base of both transmission towers where HSRs were installed. These controlled the power and revolution radar rate and sent the radar-generated signals to the radar server for processing.

Figure 15. The DCU Installed on Transmission Tower [6]

The HARRIER ADLS assessed near 12N controlled obstruction lights on designated transmission towers. As shown in figure 16, these obstruction lights included FAA type L-864/865 medium-intensity red/white lights installed on the tops of the towers, and FAA type L-810 red lights installed on the sides of the towers.

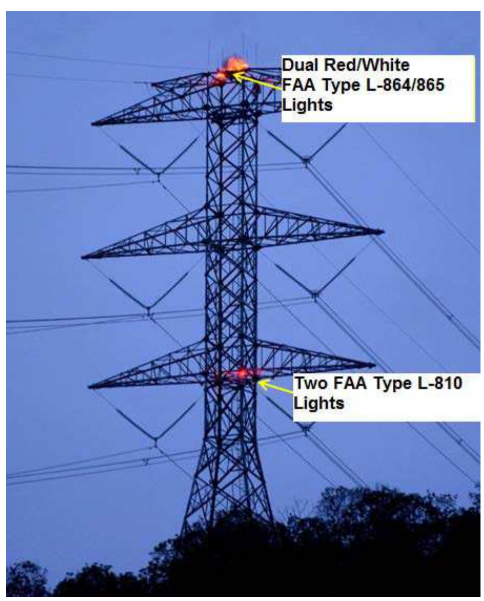
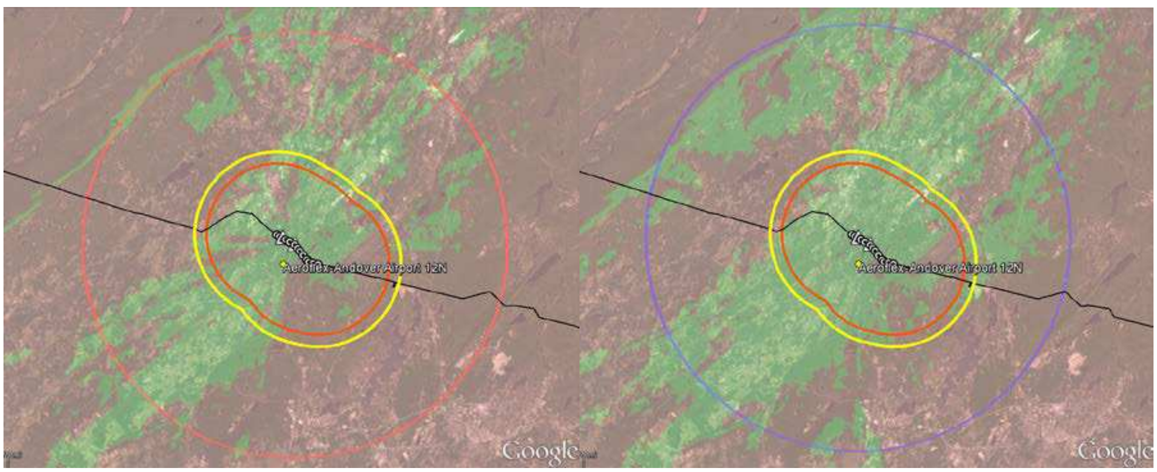


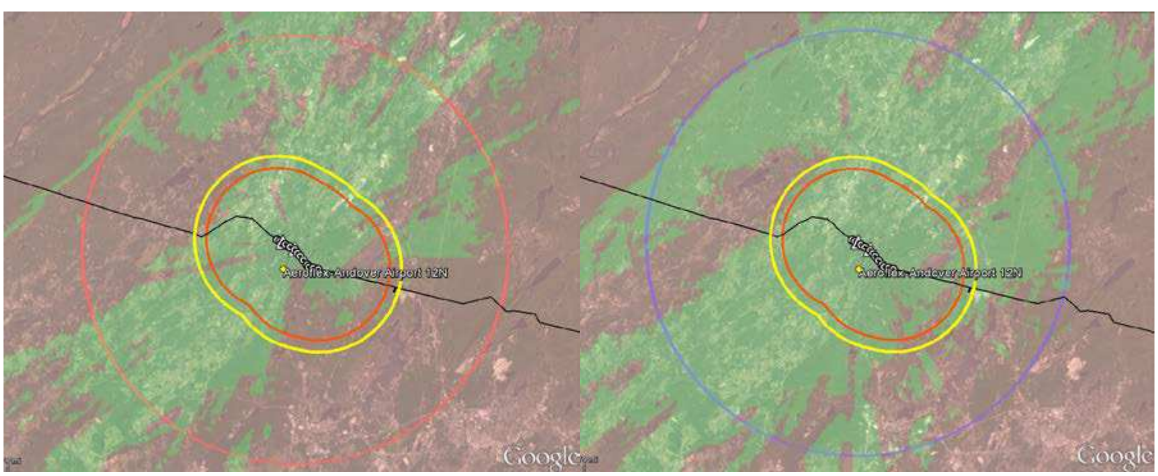
Figure 16. The FAA Type L-864/L-865 Obstruction Lights Controlled by the HARRIER ADLS [3]

Figures 17 through 19 show two-dimensional viewsheds generated by DeTect's two radar units, HSR-01 and HSR-02, for the altitudes 100, 250, and 500 ft AGL. The radar coverage displays a range of 9 NM and includes DeTect's 3.5-NM warning zone perimeter (shown in yellow), as well as the 3-NM FAA perimeter required by AC 70/7460-1L (shown as inner red circle) for reference. The left-hand images in figures 17 through 19 (figures 17(a), 18(a), and 19(a)) show the radar coverage for HSR-01, while the right-hand images (figures 17(b), 18(b), and 19(b)) show the radar coverage of HSR-02. As shown in figure 19, the warning zone was covered by HSR-02 at 500-ft AGL; however, there were portions in the southeast of the warning zone that could not be covered by either radar at 100 ft and 250 ft as a result of terrain obscuration. HSR-02 had a greater amount of coverage at all three altitudes compared to HSR-01; however, this difference was expected because HSR-01 was positioned at a lower elevation and was installed primarily to detect and track aircraft taking off from 12N.



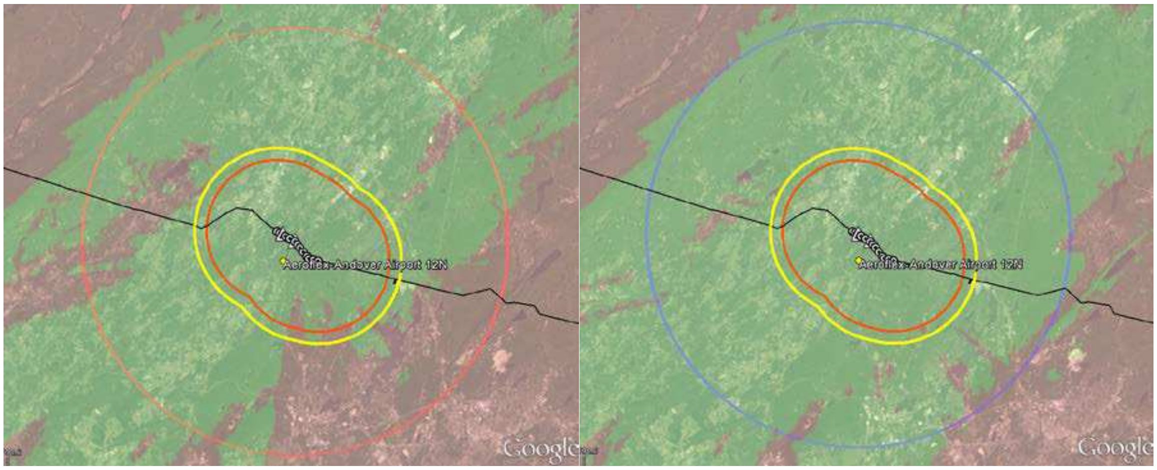
(a) (b)

Figure 17. The 100-ft AGL Viewsheds: Radars HSR-01 (a) and HSR-02 (b)



(a) (b)

Figure 18. The 250-ft AGL Viewsheds: Radars HSR-01 (a) and HSR-02 (b)



(a) (b)

Figure 19. The 500-ft AGL Viewsheds: Radars HSR-01 (a) and HSR-02 (b)

THE FAA TESTS OF THE HARRIER ADLS

<u>THE FAA FLIGHT ASSESSMENT</u>.

To properly assess the performance of the HARRIER ADLS, ATR personnel conducted a series of flight patterns to assess the system's response to aircraft operating around the warning zone (12N) at various altitudes, flight paths, speeds, etc. These were based on similar flight patterns conducted during previous FAA ADLS assessments [7 and 8]. Each pattern was designed to assess a specific ADLS parameter to determine if the system meets the requirements in AC 70/7460-1L [1]. The seven flight patterns are described below:

1. The aircraft took off from an airport inside the warning zone (12N) and flew directly towards the transmission line obstruction. The intent of this pattern was to identify how quickly the HARRIER ADLS could detect the aircraft without the benefit of early detection as it became airborne and climbed towards the obstruction.

2. The aircraft flew to and over the transmission line obstruction at 750 ft AGL three times at various headings.

3. The aircraft flew adjacent to the transmission line obstruction at 750 ft AGL two times at various headings.

4. The aircraft flew directly over the transmission line obstruction and radar sites at 1000 ft AGL.

5. The aircraft flew to and over transmission line obstruction at least 1500 ft AGL and then steeply descended into the warning zone above the transmission lines.

6. The aircraft flew to and over the transmission line at an altitude less than 1000 ft AGL, completing several tight circles immediately over the obstruction and then exited the warning zone at a different heading from the entry heading.

7. The aircraft flew over the transmission lines at 1000 ft AGL and then descended and landed at an airport inside the warning zone.

ATR personnel used the Cessna® 172 shown in figure 20 to conduct the flight patterns. The aircraft was owned and flown by a pilot with a commercial pilot certificate. All flights were operated out of 12N. Figure 21 shows a Google Earth™ map image overlaid with the flight tracks (shown in blue) recorded by a GPS unit on board the aircraft. The yellow polygon represents the HARRIER ADLS warning zone perimeter, and the orange polygon represents the FAA's required light activation perimeter.

Figure 20. Cessna 172 Used for the Flight Assessment

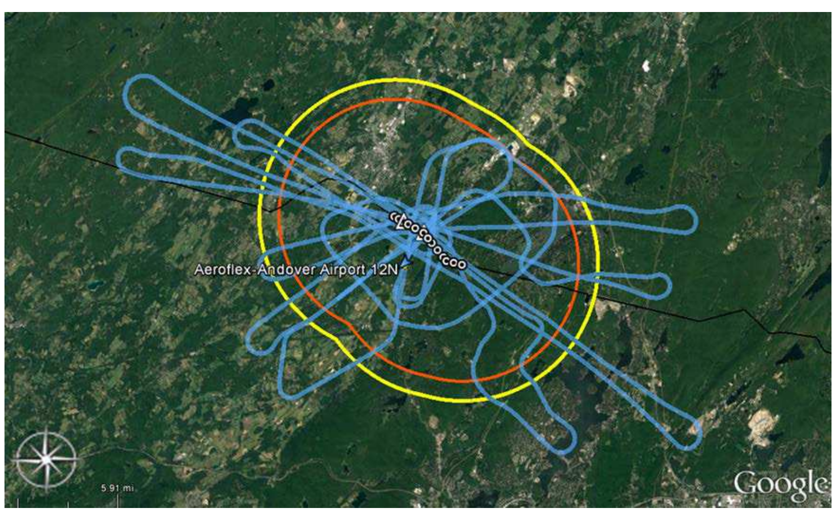


Figure 21. The GPS Flight Track Data From the Aircraft

THE FAA COMPONENT FAILURE ASSESSMENT.

In addition to the flight tests, ATR personnel also performed an assessment of the HARRIER ADLS's fail-safe mechanisms designed to monitor and respond to certain component failures. This portion of the assessment was performed on the ground at the test site where the HARRIER ADLS and associated obstruction lighting could be observed. The specific parameters that were assessed, as addressed in AC 70/7460-1L [1], included the following:

- The response of the HARRIER ADLS in the event there is a component or system failure: the HARRIER ADLS should automatically turn on all the obstruction lighting and operate in accordance with AC 70/7460-1L [1] as if the lighting operated separately from the system. The lighting must remain in this state until the HARRIER ADLS and its components are restored.

- The response of the HARRIER ADLS in the event that an individual obstruction light cannot be controlled by the HARRIER ADLS, but the rest of the HARRIER ADLS is functional: that particular obstruction light should automatically turn on and operate in accordance with AC 70/7460-1L [1] as if it was not controlled by the HARRIER ADLS, while the remaining obstruction lights continue to be controlled by the HARRIER ADLS. The obstruction lighting must remain in this state until the HARRIER ADLS and its components are restored.

- Verification that the HARRIER ADLS's communication and operational status was checked at least once every 24 hours to ensure both are operational.

- Verification that the HARRIER ADLS was able to detect an aircraft with a cross-sectional area of 1 square meter or more within the detection area.

- Verification that the HARRIER ADLS maintains a log of activity data for a period of no less than the previous 15 days. This data shall include, but not be limited to, the date, time, duration of all system activations/deactivations, track of aircraft activity, maintenance issues, system errors, communication and operational issues, lighting outages/issues, etc.

- Verification that the HARRIER ADLS components do not use devices identified in Title 47 CFR Part 15, "Radio Frequency Devices." [9]

- If equipped with a voice/audio option, verify that the HARRIER ADLS operated within the performance specifications for the voice/audio option provided in Chapter 14 of AC 70/7460-1L [1]. (See appendix A.)

RESULTS

The performance assessment of the HARRIER ADLS was based on the specifications and criteria provided in AC 70/7460-1L. This AC lists specifications for basic functions, detection performance, and system output. The following sections document the performance of the

HARRIER ADLS along with the data collected during the performance assessment and discuss how it relates to the AC 70/7460-1L performance specifications. [1]

BASIC FUNCTION ASSESSMENT.

Prior to beginning the performance assessment, ATR personnel first verified that the system was fully functional and running normally. ATR personnel verified that, without any aircraft present in the area, the system continuously scanned the area and kept the indicator lamp "off." ATR personnel at the radar site monitored the PSE&G ADLS display and communicated with the ATR personnel on board the aircraft via a two-way radio.

The ATR personnel at the radar site verified the system was tracking the aircraft as it entered the warning zone and confirmed that the system was showing the correct number of aircraft inside this zone. Figure 22 shows a screenshot of the flight track as it appeared during the assessment.

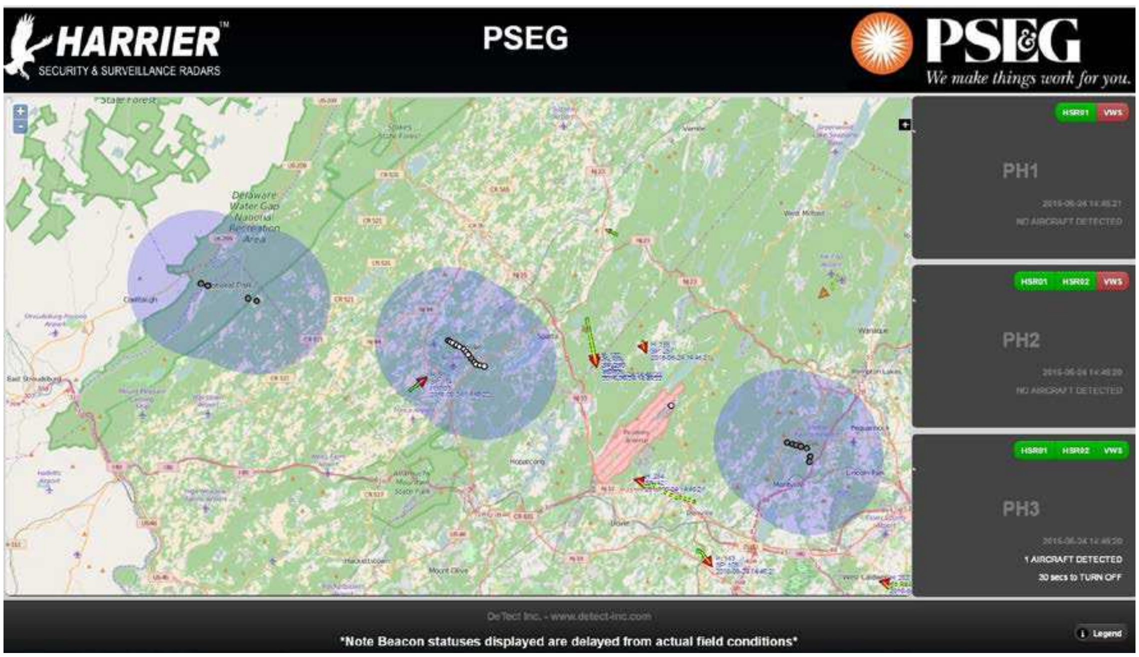


Figure 22. Flight Assessment as Observed on PSE&G ADLS Display

During the assessment flights, the HARRIER ADLS recorded radar tracks. These radar tracks were exported as Keyhole Markup Language files viewable in Google Earth. Figure 23 shows a record of the entire FAA assessment flight pattern. The dotted red lines represent the real-time tracks produced from the HARRIER ADLS, and the solid blue lines represent the tracks recorded by the GPS on board the aircraft.

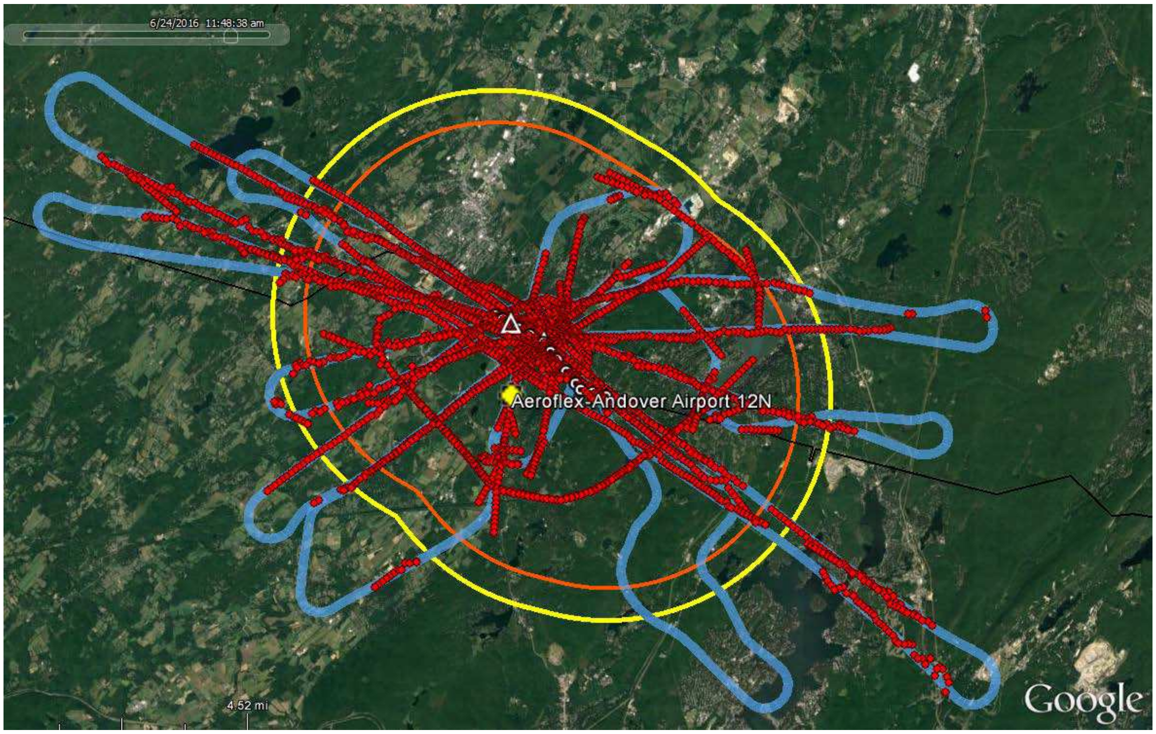


Figure 23. HARRIER ADLS Cumulative Radar Tracks Overlaid on the Aircraft's GPS Track

<u>DETECTION PERFORMANCE ASSESSMENT</u>.

To demonstrate that the HARRIER X-band ADLS was able to meet the detection performance requirements for an ADLS, ATR personnel conducted a series of flight patterns designed to assess the system's detection capabilities. Because this ADLS was an operational system necessary for the safety of other aircraft, the lights could not be turned off by ATR personnel prior to each flight pattern when other aircraft were in the area. The obstruction lights were active for 83% of the duration of the ATR flight and turned off for 17% of this time. During two flight patterns, the FAA aircraft activated the obstruction lights, confirming the functioning of this portion of the system. Descriptions of the patterns and the results of the HARRIER ADLS's detection capability are as follows:

- Takeoff from an airport inside the warning zone.

  The HARRIER ADLS was able to detect and track the aircraft within 20 seconds of the aircraft becoming airborne, a distance of approximately 0.2 NM from the departure end of Runway 3. The obstruction lights were activated prior to this pattern and remained on while the FAA aircraft was departing the warning zone. Figure 24 shows events 1-4 for this flight pattern.

- Flights to and over the transmission lines at 750 ft AGL three times at various headings.

  The HARRIER ADLS was able to detect and track the aircraft each time it entered the warning zone and flew directly over the transmission line obstruction at 750 ft AGL. On the first flights over the obstruction, the lights were activated when the aircraft was 3.3 NM from the transmission line. Radar contact was briefly lost with the aircraft shortly before exiting the FAA perimeter; however, the lights remained active during this period. The aircraft then crossed over the obstruction a second time heading southeast. Radar contact was again lost shortly before the aircraft exited the warning zone with the obstruction lights remaining on. Figures 25 and 26 show events 5-10 for these flight patterns. On the third flight over the obstruction, the lights were already activated prior to the FAA aircraft entering the warning zone; however, the HARRIER ADLS detected and tracked both aircraft. Radar contact was briefly lost as the FAA aircraft made several turns before leaving the warning zone, but the obstruction lights remained on during this period. Figure 27 shows events 11-14 for this flight pattern.

- The aircraft flew adjacent to the transmission lines at 750 ft AGL two times at various headings.

  The HARRIER ADLS was able to detect and track the aircraft as it flew adjacent to the transmission line obstruction in two different directions at 750 ft AGL. For both of these patterns, the obstruction lights were activated by other aircraft prior to the FAA aircraft entering the warning zone; however, ATR personnel confirmed the aircraft was registered as being inside the warning zone. Figures 28 and 29 show events 15-22 for these flight patterns.

- The aircraft flew directly over transmission line obstruction and radar sites at 1000 ft AGL.

  The HARRIER ADLS was able to detect and track the aircraft at a distance of 6.1 NM from the obstruction as it approached from the southeast at 1000 ft AGL. Figure 30 shows events 23-26 for this flight pattern.

- The aircraft flew to and over transmission line obstruction at least 1500 ft AGL and then steeply descended into the warning zone above the transmission lines.

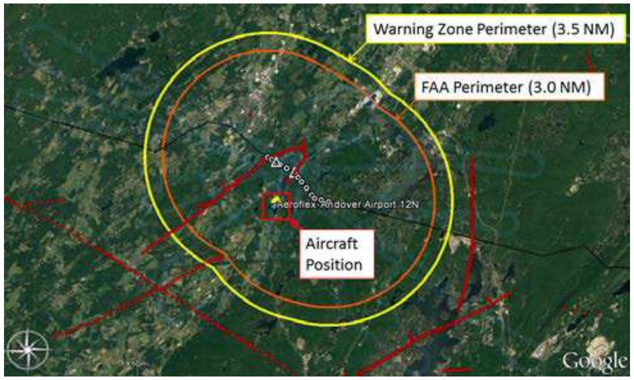
  The HARRIER ADLS was able to detect and track the aircraft as it descended from an altitude of 1500 ft AGL to 500 ft AGL. Radar contact was lost as the aircraft was exiting the warning zone to the southeast behind terrain; however the ADLS's lost aircraft timer ensured the obstruction lights remained on. Figure 31 shows events 27-30 for this flight pattern.

- The aircraft flew to and over the transmission line at an altitude less than 1000 ft AGL, completed several tight circles immediately over the obstruction, and then exited the warning zone at a different heading from the entry heading.

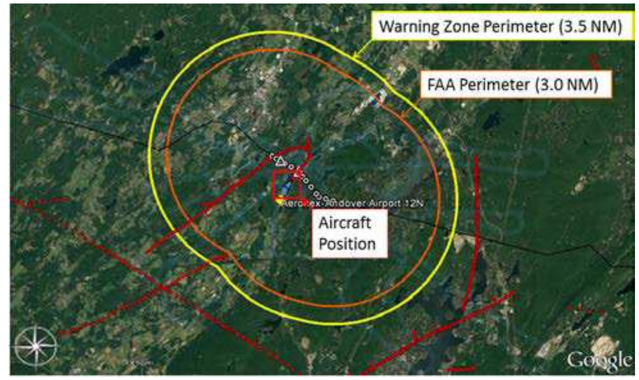
  The HARRIER ADLS detected the aircraft at a distance of 3.5 NM from the transmission line obstructions. The system was able to track the aircraft as it conducted four steep, circling turns within the warning zone over the radars and obstructions. Figure 32 shows events 31-34 for this flight pattern.

- The aircraft flew over the transmission lines at 1000 ft AGL, then descended and landed at an airport inside the warning zone.

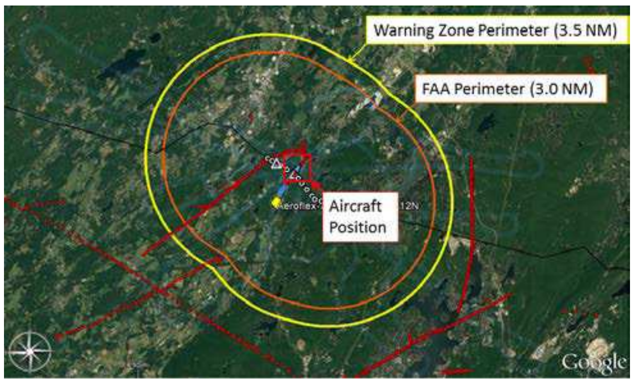
  The HARRIER ADLS was able to detect the aircraft and activate the obstruction lights when the aircraft reached a distance of 3.4 NM from the obstructions. The aircraft continued to be tracked as it flew directly over the obstruction and radars. Radar contact became intermittent as the aircraft descended in the traffic pattern for landing on Runway 3. The HARRIER ADLS turned off the obstruction lights within 90 seconds of the aircraft landing at 12N. Figures 33 and 34 show events 35-38 and 39-41, respectively, for this flight pattern.



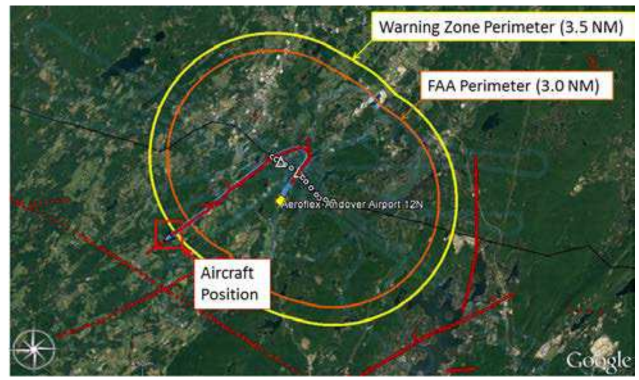
Event 1:
- Aircraft begins its takeoff from inside the warning zone.
- Aircraft is not detected.
- Lights are on prior to takeoff.



Event 2:
- Aircraft takes off and is detected by radar.
- Aircraft is registered within warning zone.
- Lights remain on.

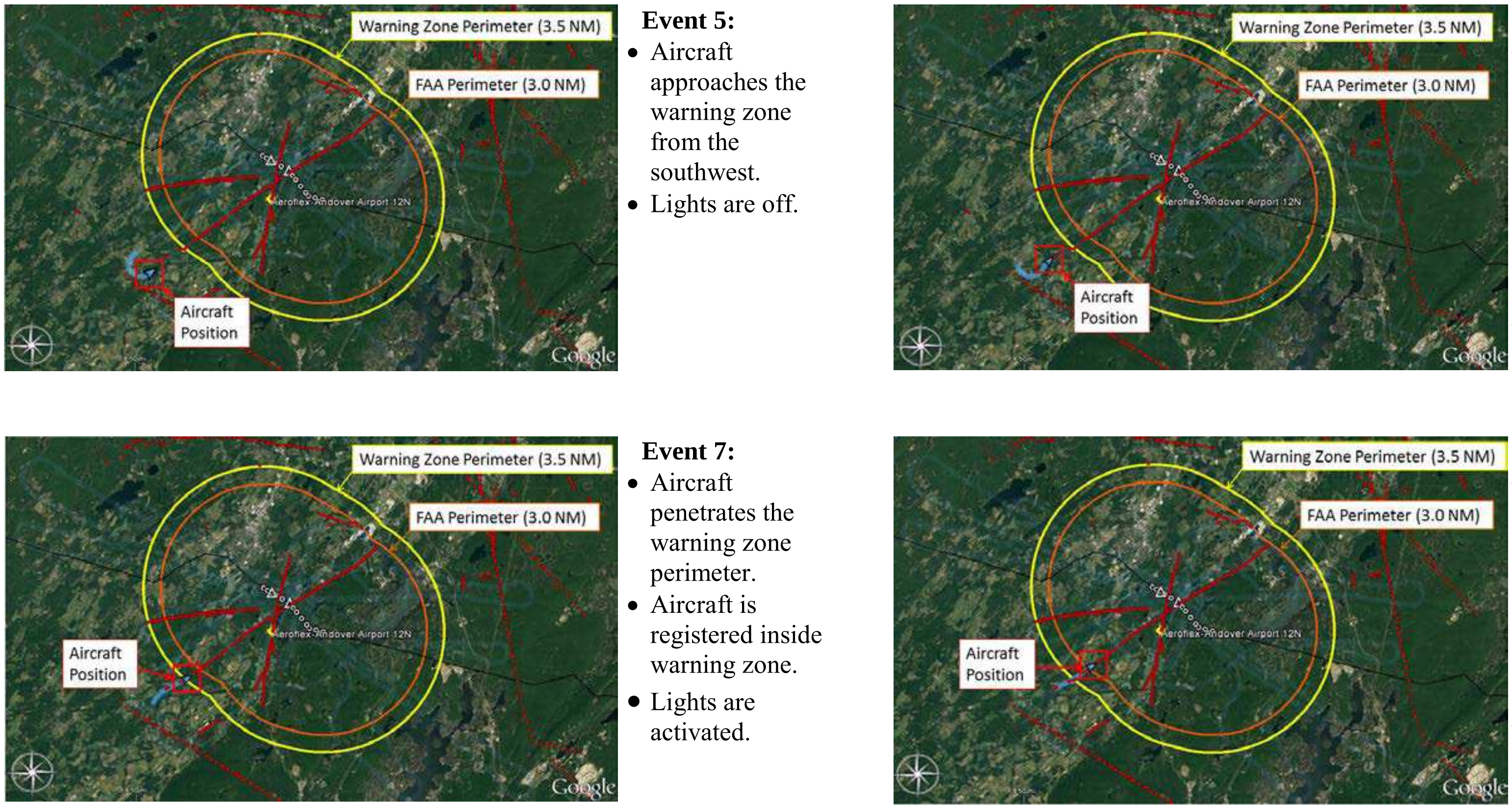


Event 3:
- Aircraft flies directly over the transmission lines and radar.
- Aircraft continues to be tracked by radar.
- Lights remain on.



Event 4:
- Aircraft exits the warning zone perimeter heading southwest.
- Lights remain on until the ADLS countdown reaches zero.

Figure 24. Aircraft Takes Off Inside Warning Zone and Flies Directly Over Transmission Lines (Events 1-4)



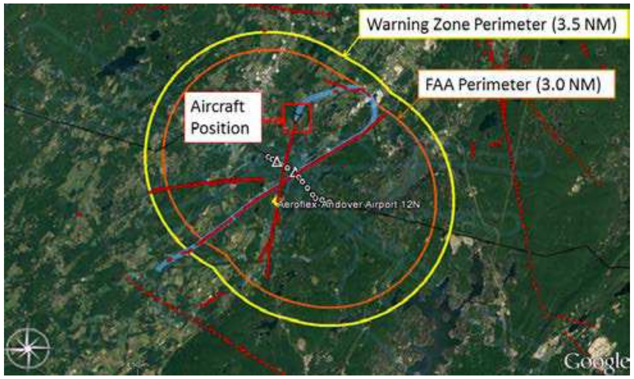
Event 5:
- Aircraft approaches the warning zone from the southwest.
- Lights are off.

Event 6:
- Aircraft is detected and tracked by the radar as it approaches the warning zone perimeter.
- Lights are off.

Event 7:
- Aircraft penetrates the warning zone perimeter.
- Aircraft is registered inside warning zone.
- Lights are activated.

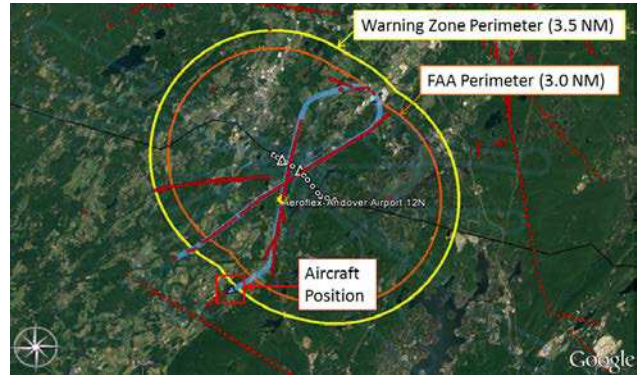
Event 8:
- The lights are on prior to the aircraft entering FAA-required perimeter.
- Aircraft is tracked flying through the warning zone over the obstructions.

Figure 25. Flights Directly Through the Warning Zone to the Northeast and South (Events 5-8)



Event 9:

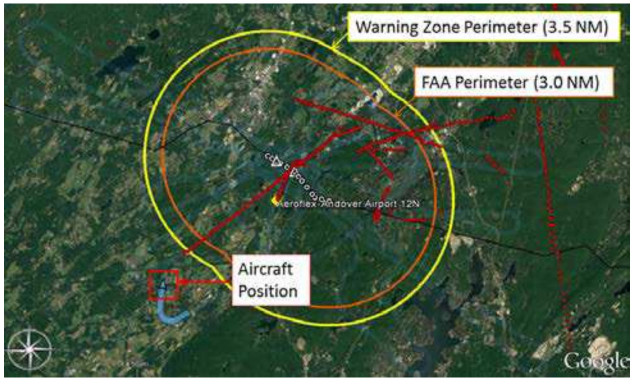
- Aircraft completes a turn within the warning zone and approaches the transmission lines from the northeast.
- Aircraft briefly lost and reacquired by the radar, activating the ADLS timer.
- Lights remain on.



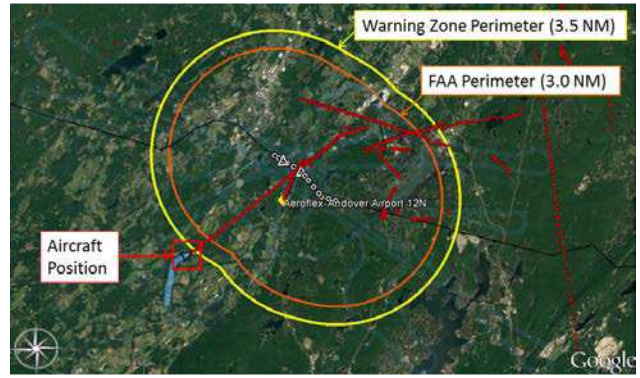
Event 10:

- Aircraft flies over the transmission lines and exits the warning zone heading southwest.
- Radar contact is lost shortly before aircraft exits the warning zone.
- Lights remain on.

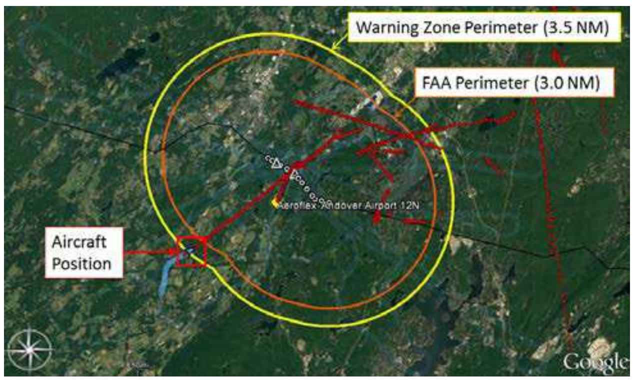
Figure 26. Continuation of Flight Directly Through the Warning Zone to the Northeast and South (Events 9 and 10)



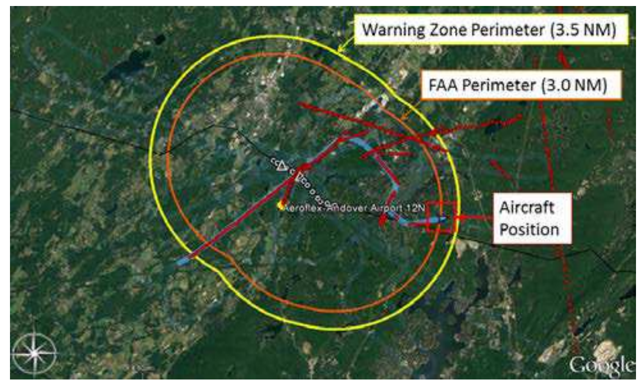
Event 11:
- Aircraft approaches the warning zone from the southwest
- Lights remain on.



Event 12:
- Aircraft is detected and tracked by the radar before reaching the warning zone.
- Lights remain on.

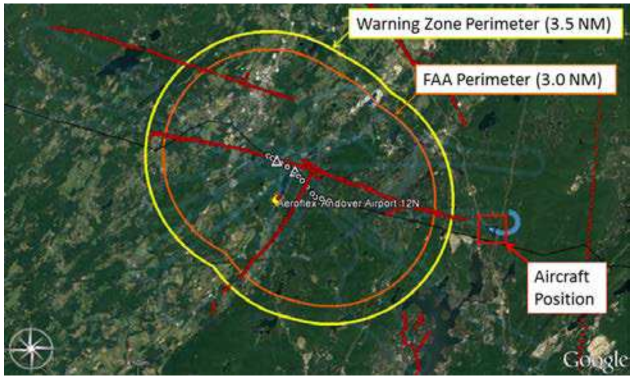


Event 13:
- Aircraft penetrates the warning zone perimeter.
- Aircraft is registered inside warning zone.
- Lights remain on.

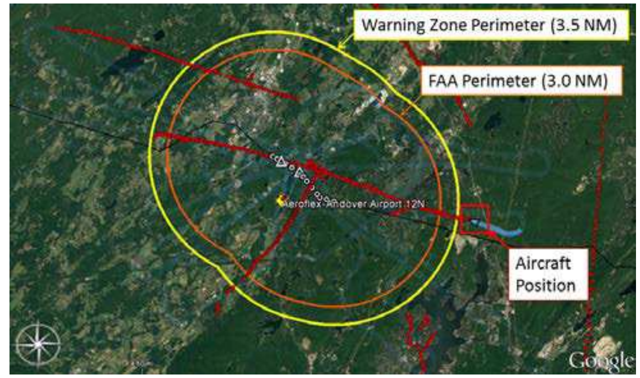


Event 14:
- Aircraft begins a series of turns before exiting the warning zone.
- Radar contact is briefly lost at times during the turns, activating the ADLS timer.
- Lights remain on.

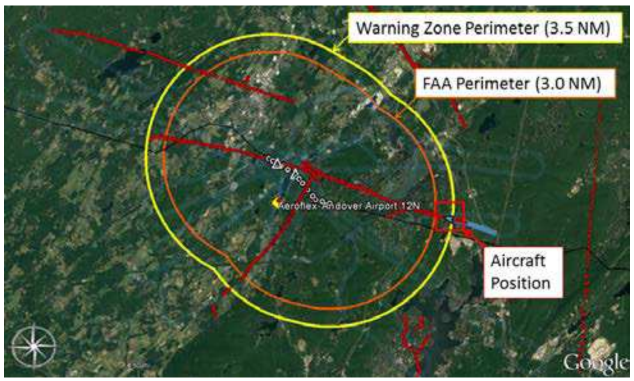
Figure 27. Flight Through the Warning Zone With Turns, Exiting to the East (Events 11-14)



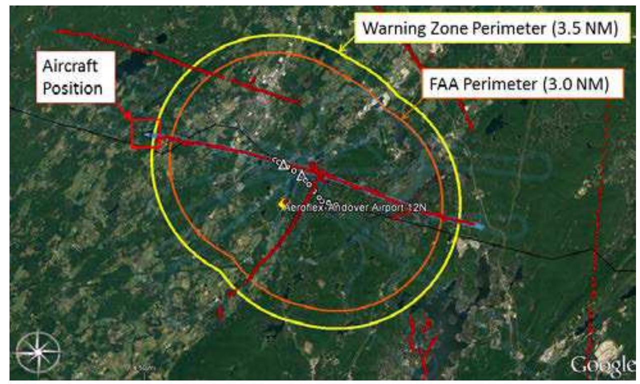
Event 15:
- Aircraft approaches the warning zone from the east.
- Lights remain on.



Event 16:
- Aircraft is detected by radar and is tracked before entering the warning zone.
- Lights remain on.

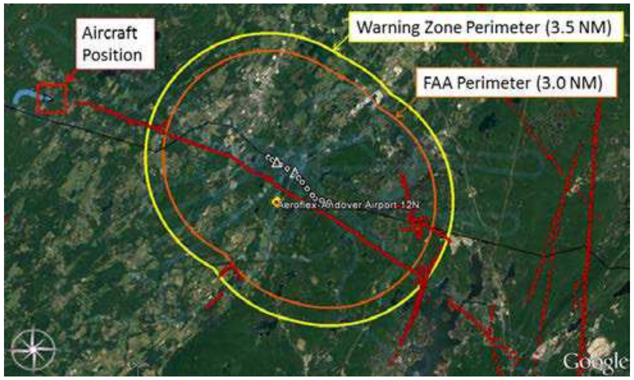


Event 17:
- Aircraft penetrates the warning zone perimeter and flies along the t ransmission line.
- Aircraft is registered inside warning zone.
- Lights remain on.

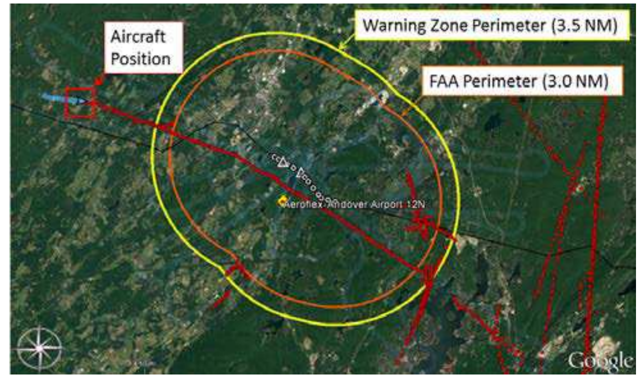


Event 18:
- Aircraft exits the warning zone to the northwest.
- Lights remain on.

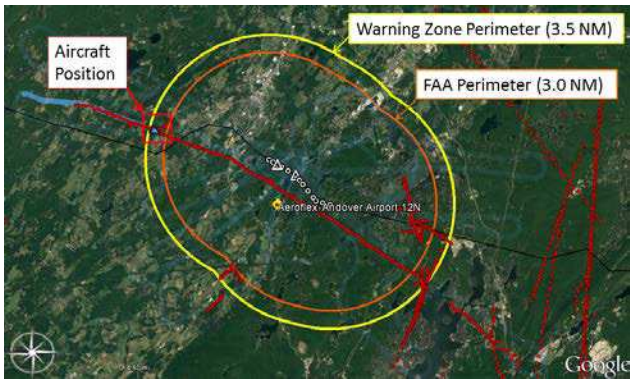
Figure 28. Flight Adjacent to the Transmission Lines, Exiting Warning Zone to the Northwest (Events 15-18)



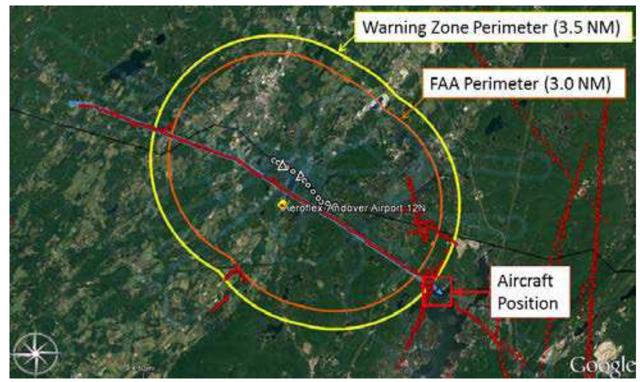
Event 19:
- Aircraft approaches the warning zone from the northwest
- Lights remain on.



Event 20:
- Aircraft is detected by radar and is tracked before entering the warning zone.
- Lights remain on.

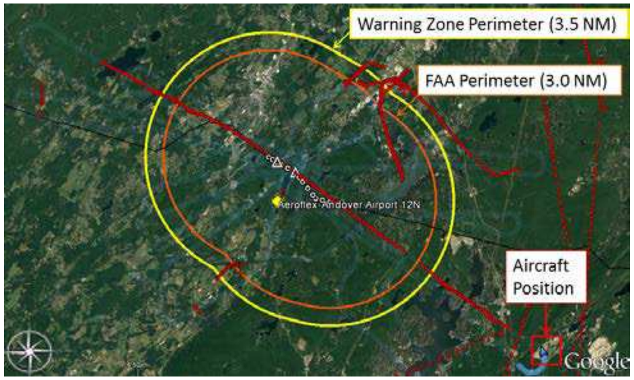


Event 21:
- Aircraft penetrates the warning zone perimeter.
- Aircraft is registered inside warning zone.
- Lights remain on.



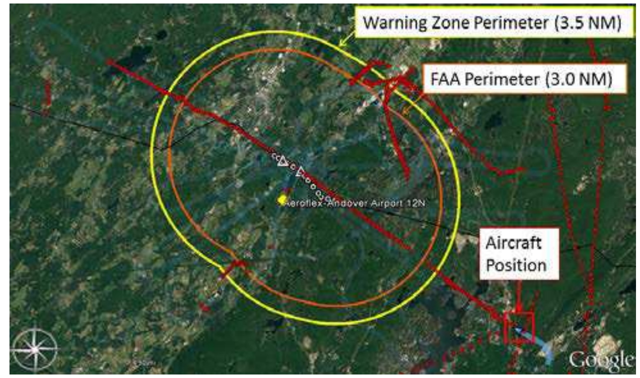
Event 22:
- Aircraft exits the warning zone to the southeast.
- Lights remain on.

Figure 29. Flight Adjacent to the Transmission Lines, Exiting Warning Zone to the Southeast (Events 19-22)



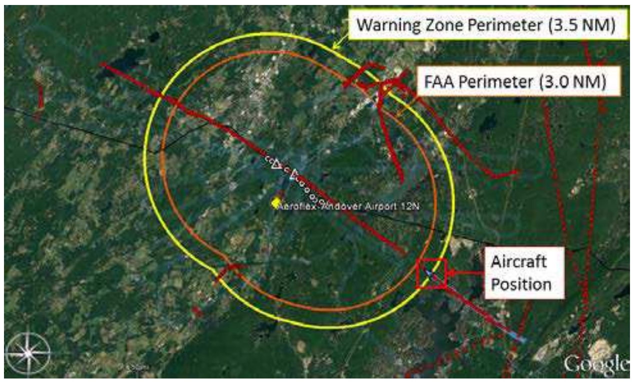
Event 23:

- Aircraft approaches the warning zone from the southeast.
- Lights remain on.



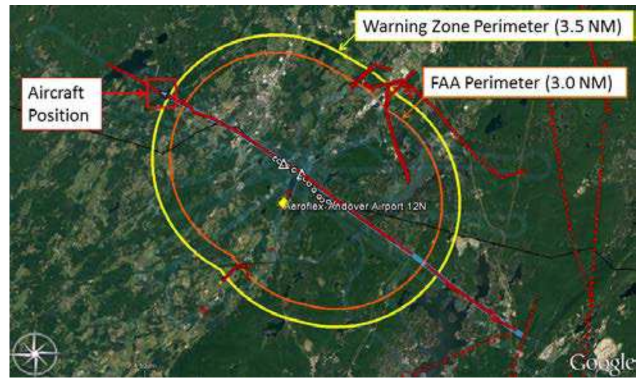
Event 24:

- Aircraft is detected and is tracked by radar.
- Lights remain on.



Event 25:

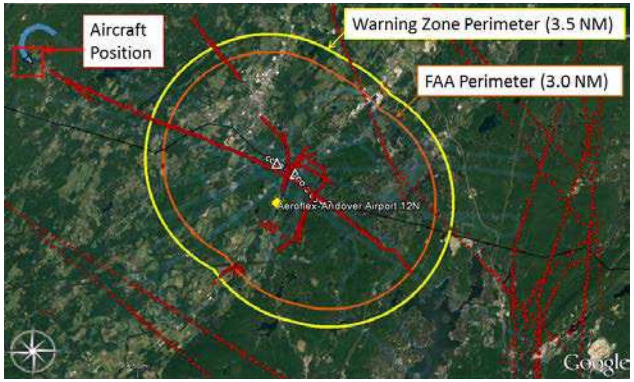
- Aircraft penetrates the warning zone perimeter.
- Aircraft is registered inside warning zone.
- Lights remain on.



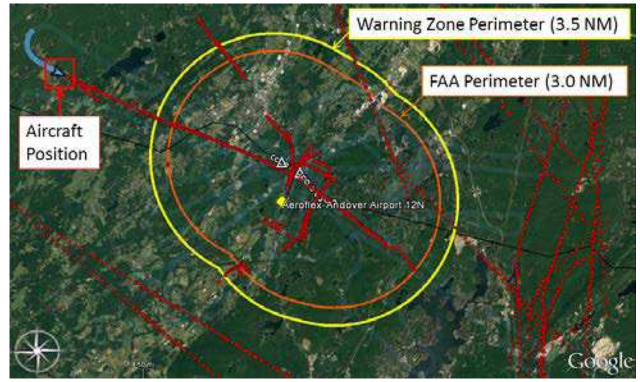
Event 26:

- Aircraft exits the warning zone to the northwest.
- Lights remain on.

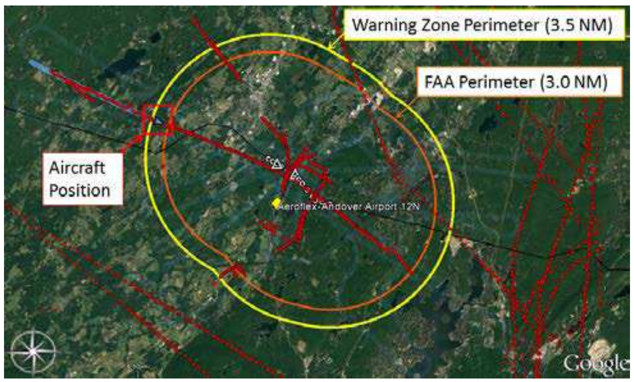
Figure 30. Flight Directly Through the Warning Zone to the Northwest (Events 23-26)



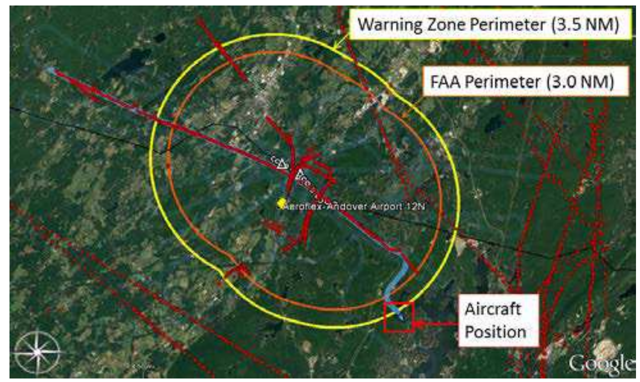
Event 27:
- Aircraft approaches the warning zone from the northwest at 1500 ft AGL.
- Lights are on.



Event 28:
- Aircraft is detected and is tracked by radar.
- Lights are on.

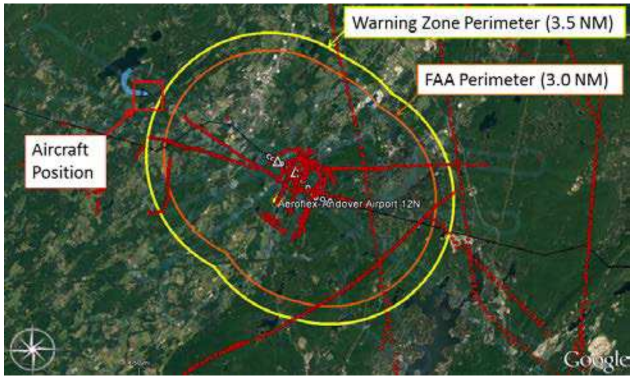


Event 29:
- Aircraft penetrates the warning zone perimeter.
- Aircraft is registered inside warning zone as it descends to 500 ft AGL.
- Lights remain on.

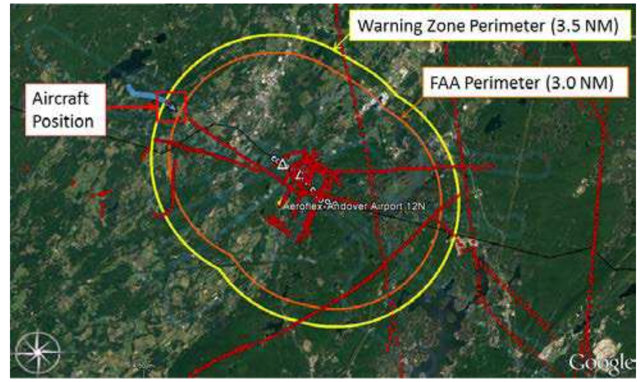


Event 30:
- Aircraft makes two 90-degree turns before exiting warning zone to the southeast.
- Radar contact is lost prior to aircraft exiting the zone.
- Lights remain on.

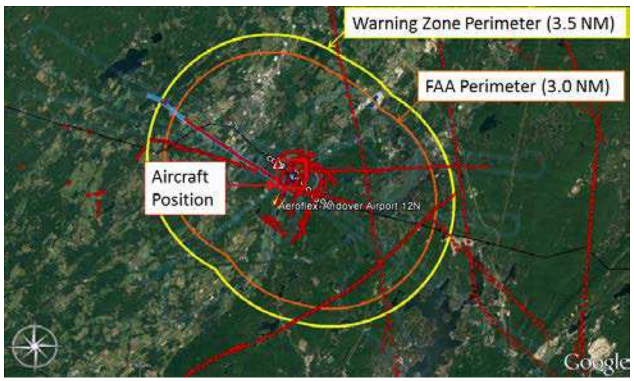
Figure 31. Descending Flight Into the Warning Zone (Events 27-30)



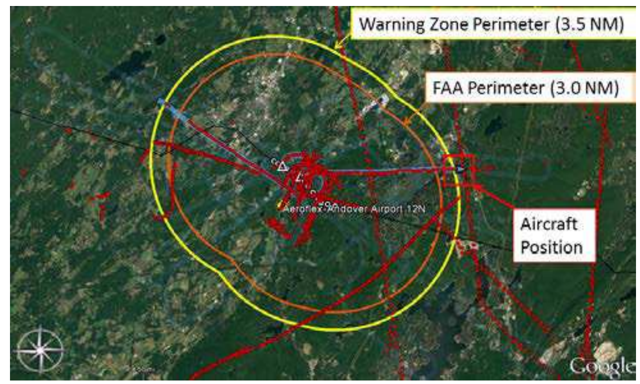
Event 31:
- Aircraft approaches the warning zone from the northwest.
- Lights remain on.



Event 32:
- Aircraft penetrates the warning zone perimeter.
- Aircraft is registered inside warning zone.
- Lights remain on.

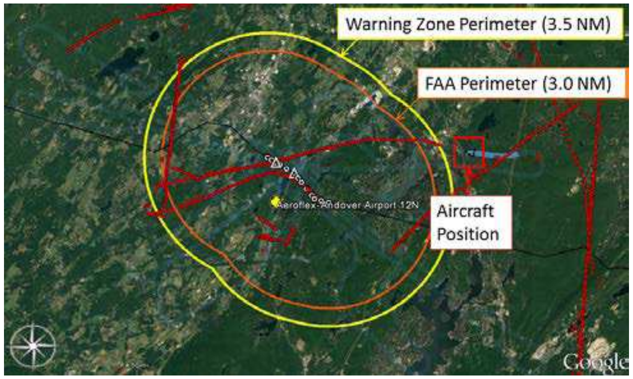


Event 33:
- Completes four steep turns over the transmission lines and radars.
- Lights remain on.



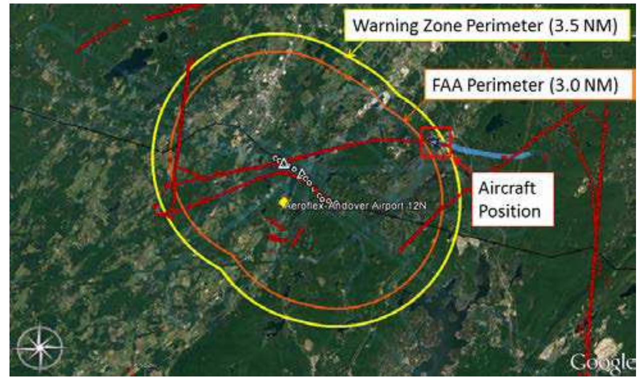
Event 34:
- Aircraft exits the warning zone to the east.
- Lights remain on until ADLS countdown timer reaches zero.

Figure 32. Circling Flight Within the Warning Zone (Events 31-34)



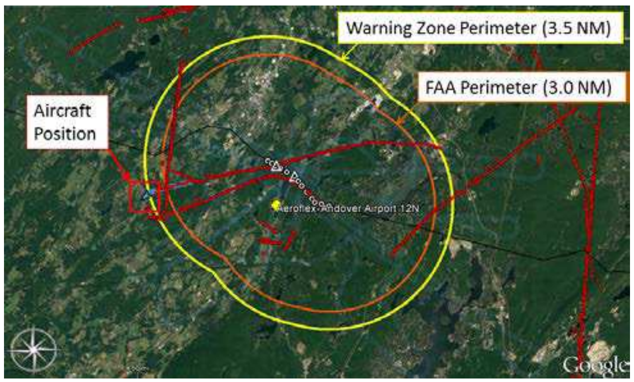
Event 35:

- Aircraft approaches the warning zone from the east.
- Lights are off.



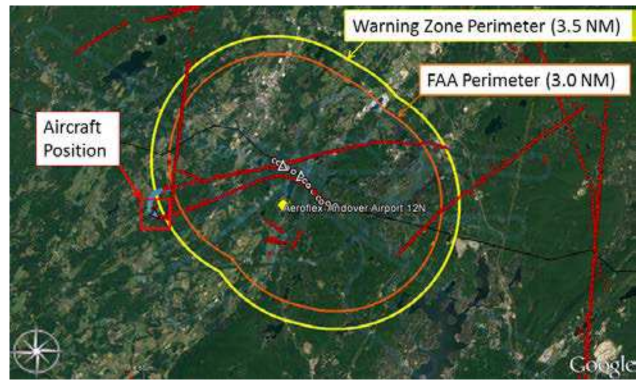
Event 36:

- Aircraft penetrates the warning zone perimeter.
- Aircraft is registered inside warning zone.
- Lights are activated.



Event 37:

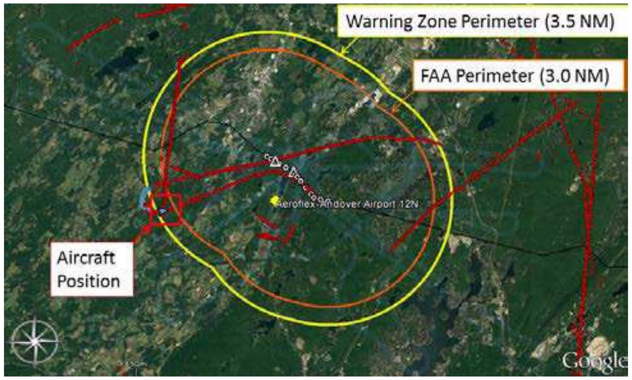
- Aircraft exits the warning zone to the east.
- Radar contact with aircraft lost.
- Countdown timer begins.
- Lights remain on.



Event 38:

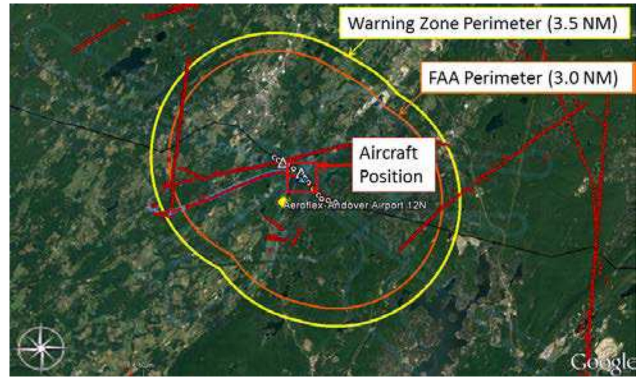
- Aircraft turns back towards obstruction from the west and is reacquired by radar.
- Lights remain on.

Figure 33. First Flight Over the Obstruction and Landing Inside the Warning Zone (Events 35-38)



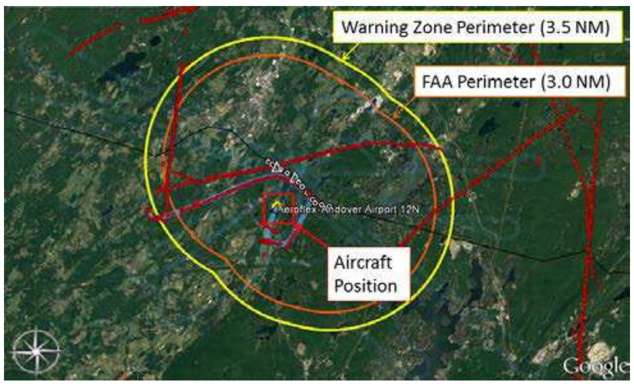
Event 39:

- Aircraft penetrates the warning zone perimeter from the west.
- Aircraft is registered inside warning zone.
- Lights remain on.



Event 40:

- Aircraft turns to fly directly over the transmission lines and enters the 12N traffic pattern.
- Lights remain on.



Event 41:

- Aircraft lands at 12N.
- Radar contact is lost after landing.
- Lights remain on until the ADLS countdown reaches zero.

Figure 34. Second Flight Over the Obstruction and Landing Inside the Warning Zone (Events 39-41)

COMPONENT FAILURE ASSESSMENT.

To demonstrate that the HARRIER X-band ADLS was able to meet the component failure requirements for an ADLS, ATR personnel conducted a series of activities designed to test the system's component failure responses. Descriptions of the activities and the results of the HARRIER ADLS's failure response are as follows:

- Individual Component and Obstruction Light Control Failure

  ATR personnel observed that when individual components of the HARRIER ADLS were disconnected or disabled, the ADLS automatically turned on all the obstruction lights as if the lights operated separately from the system. The obstruction lighting remained in this state until the HARRIER ADLS was returned to online status. Once the lighting system recognized the HARRIER ADLS's "heartbeat," which indicated the system was operating correctly, the lights were turned off.

- Communication and Status Monitoring

  ATR personnel verified that the HARRIER ADLS communication and operational statuses were able to be checked at least once every 24 hours to ensure both were operational.

- Target Size

  ATR personnel confirmed that the HARRIER ADLS could identify an object with a cross-sectional area of 1 square meter or more within the detection area. This was accomplished by flying an aircraft straight toward the HARRIER ADLS's radar unit, and resulted in the system being able to detect the narrow profile of the aircraft.

- Activity Log

  PSE&G and DeTect personnel demonstrated to the ATR personnel that the radar data could be stored for an indefinite amount of time, depending on the user's requirement, which satisfies the 15-day requirement of AC 70/7460-1L [1].

- FCC Part 15 Compliance

  Based on the documentation that DeTect personnel provided to ATR personnel, it was determined that the HARRIER ADLS components do not use FCC Part 15 devices [9]. Lighting control subsystems connected to the HARRIER ADLS used Part 15 components; however, these are not critical to the functioning of the ADLS itself.

- Audio/Voice Option

  The DeTect ADLS does not currently offer a voice/audio option; therefore, this was not assessed. As stated in AC 70/7460-1L, this is not a required ADLS component [1].

CONCLUSIONS

The Federal Aviation Administration (FAA) Airport Technology Research and Development Section assessed the X-band radar version of the DeTect™ HARRIER® Aircraft Detection Lighting System (ADLS) installed and owned by the Public Service Electric and Gas Company on transmission towers in the vicinity of Aeroflex-Andover Airport, near Andover, New Jersey. A performance assessment consisting of demonstrations, flight testing, and data analysis was conducted on June 24, 2016. In this performance assessment, a series of flight patterns were flown against the DeTect HARRIER ADLS to demonstrate that it could meet the FAA's performance requirements for an ADLS. The DeTect HARRIER X-band ADLS performed according to the manufacturer's specifications and met the performance requirements specified in Chapter 14 of FAA Advisory Circular 70/7460-1L, "Obstruction Marking and Lighting."

REFERENCES

1. Federal Aviation Administration (FAA), "Obstruction Marking and Lighting," Advisory Circular 70/7460-1L, December 4, 2015.

2. United States (U.S.) Federal Register, Title 14 Code of Federal Regulations (CFR), Part 77, "Safe, Efficient Use, and Preservation of the Navigable Airspace," U.S. Government Publishing Office, Washington, DC.

3. DigitaLogic, "IGIN-EFS (IGIN-Enterprise to Field System) - Advanced IT Platform for ADLS," November 2016.

4. DeTect, Inc., "Technical Data Sheet – HARRIER® ADLS," April 2016.

5. DeTect, Inc., "Briefing – HARRIER ADLS," 2015.

6. DeTect, Inc., "Summary of FAA ADLS Test," June 2016.

7. Patterson, James, Jr., "Performance Assessment of the Laufer Wind Aircraft Detection System as an Aircraft Detection Lighting System, FAA technical note DOT/FAA/TC-TN15/54, May 2016.

8. Patterson, James, Jr., "Performance Assessment of the Terma Obstruction Light Control System as an Aircraft Detection Lighting System" FAA technical note DOT/FAA/TC-TN16/41, June 2016.

9. U.S. Federal Register, Title 47 CFR, Part 15, "Radio Frequency Devices," U.S. Government Publishing Office, Washington, DC.

APPENDIX A—ADVISORY CIRCULAR 70/7460-1L, CHAPTER 14 AIRCRAFT DETECTION LIGHTING SYSTEMS[1]

CHAPTER 14. AIRCRAFT DETECTION LIGHTING SYSTEMS

14.1 Purpose.

Aircraft Detection Lighting Systems (ADLS) are sensor-based systems designed to detect aircraft as they approach an obstruction or group of obstructions; these systems automatically activate the appropriate obstruction lights until they are no longer needed by the aircraft. This technology reduces the impact of nighttime lighting on nearby communities and migratory birds and extends the life expectancy of obstruction lights.

14.2 General Standards.

14.2.1 The system should be designed with sufficient sensors to provide complete detection coverage for aircraft that enter a three-dimensional volume of airspace, or coverage area, around the obstruction(s) (see Figure A-27 in Appendix A), as follows:

1. Horizontal detection coverage should provide for obstruction lighting to be activated and illuminated prior to aircraft penetrating the perimeter of the volume, which is a minimum of 3 NM (5.5 km) away from the obstruction or the perimeter of a group of obstructions.

2. Vertical detection coverage should provide for obstruction lighting to be activated and illuminated prior to aircraft penetrating the volume, which extends from the ground up to 1000 feet (304 m) above the highest part of the obstruction or group of obstructions, for all areas within the 3 NM (5.5 km) perimeter defined in subparagraph 14.2.1 1 above.

3. In some circumstances, it may not be possible to meet the volume area defined above because the terrain may mask the detection signal from acquiring an aircraft target within the 3 NM (5.5 km) perimeter. In these cases, the sponsor should identify these areas in their application to the FAA for further evaluation.

4. In some situations, lighting not controlled by the ADLS may be required when the 3 NM (5.5 km) perimeter is not achievable to ensure pilots have sufficient warning before approaching the obstructions.

14.2.2 The ADLS should activate the obstruction lighting system in sufficient time to allow the lights to illuminate and synchronize to flash simultaneously prior to an aircraft penetrating the volume defined above. The lights should remain on for a specific time period, as follows:

---

[1] Federal Aviation Administration, "Obstruction Marking and Lighting," Advisory Circular (AC) 70/7460-1L – Change 1, October 8, 2016.

1. For ADLSs capable of continuously monitoring aircraft while they are within the 3 NM/1,000 foot (5.5 km/304 m) volume, the obstruction lights should stay on until the aircraft exits the volume. In the event detection of the aircraft is lost while being continuously monitored within the 3 NM/1,000 foot (5.5 km/304 m) volume, the ADLS should initiate a 30-minute timer and keep the obstruction lights on until the timer expires. This should provide the untracked aircraft sufficient time to exit the area and give the ADLS time to reset.

2. For ADLSs without the capability of monitoring aircraft targets in the 3 nm/1,000 foot (5.5 km/304 m) volume, the obstruction lights should stay on for a preset amount of time, calculated as follows:

a. For single obstructions: 7 minutes.

b. For groups of obstructions: (the widest dimension in nautical miles + 6) x 90 seconds equals the number of seconds the light(s) should remain on.

14.2.3 Acceptance of ADLS applications will be on a case-by-case basis and may be modified, adjusted, or denied based on proximity of the obstruction or group of obstructions to airports, low-altitude flight routes, military training areas, or other areas of frequent flight activity. It may be appropriate to keep certain obstructions closest to these known activity areas illuminated during the nighttime hours, while the remainder of the group's obstruction lighting is controlled by the ADLS.

14.2.4 Project sponsors requesting ADLS use should include in their application maps or diagrams indicating the location of the proposed sensors, the range of each sensor, and a visual indication showing how each sensor's detection arc provides the full horizontal and vertical coverage, as required under paragraph 14.2.1. In the event that detection coverage is not 100 percent due to terrain masking, project sponsors should provide multiple maps or diagrams that indicate coverage at the affected altitudes. A sample diagram is shown in Figure A-27 in Appendix A.

14.2.5 Types of ADLS Component or System Failure Events.

1. In the event of an ADLS component or system failure, the ADLS should automatically turn on all the obstruction lighting and operate in accordance with this AC as if it was not controlled by an ADLS. The obstruction lighting must remain in this state until the ADLS and its components are restored.

2. In the event that an ADLS component failure occurs and an individual obstruction light cannot be controlled by the ADLS, but the rest of the ADLS is functional, that particular obstruction light should automatically turn on and operate in accordance with this AC as if it was not controlled by an ADLS, and the remaining obstruction lights can continue to be controlled by the ADLS. The obstruction lighting will remain in this state until the ADLS and its components are restored.

3. Complete light failure should be addressed in accordance with Chapter 2 paragraph 2.4.

14.2.6 The ADLS's communication and operational status shall be checked at least once every 24 hours to ensure both are operational.

14.2.7 The ADLS should be able to detect an aircraft with a cross-sectional area of 1 square meter or more within the volume, as required in subparagraphs 14.2.1 1 and 14.2.1 2.

14.2.8 Each ADLS installation should maintain a log of activity data for a period of no less than the previous 15 days. This data should include, but not be limited to, the date, time, duration of all system activations/deactivations, track of aircraft activity, maintenance issues, system errors, communication and operational issues, lighting outages/issues, etc.

14.2.9 Operational Frequencies.

1. Unlicensed devices (including FCC Part 15) devices cannot be used for this type of system.

2. Any frequency used for the operation of ADLS must be individually licensed through the FCC.

14.3 Voice/Audio Option.

14.3.1 ADLS may include an optional voice/audio feature that transmits a low-power, audible warning message to provide pilots additional information on the obstruction they are approaching.

14.3.2 The audible transmission should be in accordance with appropriate FAA and FCC regulations.

14.3.3 The audible transmission should be over an aviation frequency licensed by the FCC and authorized under the Code of Federal Regulations Title 47- Part 87.483 (excluding 121.5 MHz).

Note: Using air traffic control frequencies in the 117.975-MHz to 137-MHz frequency band is prohibited for this operation.

14.3.4 The audible message should consist of three quick tones, followed by a verbal message that describes the type of obstruction the system is protecting. Appropriate terms to be used include tower(s), wind turbine(s), or power line(s).

14.3.5 The audible message should be repeated three times or until the system determines the aircraft is no longer within the audible warning area defined in the following paragraph.

14.3.6 The audible message should be considered as a secondary, final warning and should be activated when an aircraft is within 1/2 NM (926 m) horizontally and 500 feet (152 m) vertically of the obstruction. The use of, or variation to, the audible warning zone may occur, depending on site-specific conditions or obstruction types.

APPENDIX B—HARRIER AIRCRAFT DETECTION LIGHTING SYSTEM INFORMATION

Technical Data Sheet

HARRIER

Aircraft Detection Lighting System

HARRIER

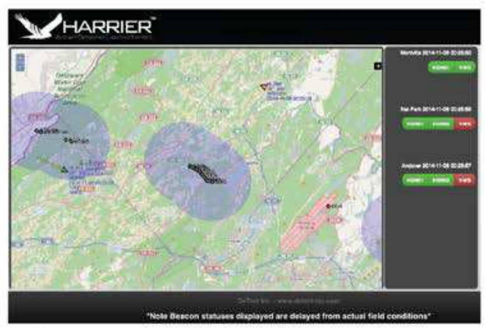
Aircraft DeTection Lighting System

SUMMARY SPECIFICATIONS

subject to change without notice

Model :	ADLS-200d
Application:	High resolution, airspace surveillance with automatic activation of obstruction lighting when aircraft are detected approaching to within defined perimeters
Configuration:	Fully self-contained fixed system for obstruction lighting activation for wind farm, power transmission, communication and other projects that require automated obstruction lighting
Sensors:	200 watt solid state S- or X-band radar sensors with Doppler processing; Traffic Advisory System (TAS) and Automatic Dependent Surveillance - Broadcast (ADS-B) secondary surveillance for cooperative aircraft
Operation:	Extended range detection of cooperative (transponder equipped) & non-cooperative aircraft & ultralights with automatic activation of obstruction warning lights at user-defined perimeters (10 mile minimum recommended)
Operating Range:	Full 360 degree 3D coverage with detection to 20 miles
Power:	110/220 VAC, 60/30 amps service with UPS back-up & power conditioning (30 minutes) & optional auto-start single or dual 6 kW propane or diesel generator & fuel tank to support 10-20 days 24-7 operation
Network:	TCPIP connection supports multi-user web remote real-time system display, control & data access via fiber optic

ABOVE: The HARRIER ADLS is typically supplied as a fixed, self-contained skid mounted system for ground based installation. BELOW: HARRIER ADLS web display



Advantages of the *HARRIER ADLS*

- Longer range detection provides greater safety margin
- Secondary transponder receivers for detection backup
- Fewer sensors required for complete coverage
- Ground-based sensors with lower installation & O&M costs
- Based on FAA tested, military-grade technology
- Advanced solid-state Doppler technology
- Meets or exceeds all FAA, Transport Canada and European requirements
- Multi-functional capable for ADLS, site security & bird detection from a single sensor
- Fully compatible with all SCADA systems and turbines
- ADSB integration minimizes lighting activation from high altitude commercial aircraft

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DOC# TDS-HARRIER ADLS-092116

TECHNICAL DATA SHEET
HARRIER AIRCRAFT DETECTION LIGHTING SYSTEM

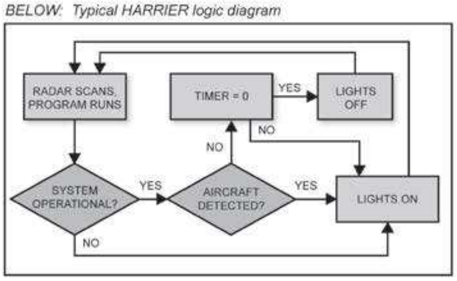
HARRIER

Many stakeholders recognize the environmental and social impacts of obstruction lighting at wind farms and similar project sites and are exploring strategies to mitigate the impact on surrounding communities. In response, DeTect developed the HARRIER Aircraft Detection Lighting System (ADLS), an advanced ground radar-based ADLS using high-resolution airspace surveillance with automated activation of wind farm obstruction lighting when aircraft are detected within defined parameters. DeTect HARRIER ADLS systems are currently operating in the US, Canada and Europe.

The HARRIER ADLS system provides extended-range detection of cooperative and noncooperative aircraft, including ultralight aircraft, with 360-degree coverage and detection up to 20 miles range, but only aircraft entering a custom configured exclusion zone will trigger the activation of the obstruction lighting. The HARRIER ADLS is also multi-function capable and can provide site security for aircraft, ultralights, and drones as well as bird detection for environmental monitoring and risk mitigation. The system is fully networkable and remotely controllable with real-time data display, data transmission, diagnostics, and Health and Status Monitoring (HSM).

DeTect's ADLS uses patented Operational Risk Management (ORM) algorithms and operates in a failsafe manner where the lights are held in an 'ON' state by the system unless a target is not detected within the defined risk zone. When the sensors detect an aircraft, the obstruction lights are activated. A "heartbeat" indicator provides constant system status reading of the ADLS and its network. Should the ADLS go offline, or heartbeat indicator lost, the lights will automatically activate and remain illuminated until the system returns online.

BELOW: Typical HARRIER logic diagram



HARRIER uses an advanced solid-state S- or X-Band Doppler surveillance radar that has the ability to penetrate into moderate rain. The HARRIER ADLS logic always errs on the side of safety and if severe weather is detected by the HARRIER system, the system will automatically activate the lights. The HARRIER ADLS also incorporates secondary surveillance using a Traffic Avoidance System (TAS) and Automatic Dependent Surveillance – Broadcast (ADS-B) receivers. The radar sensors, TAS antennas and ADS-B antennas are ground-based resulting in lower installation and O&M cost over the life of the project. The system electronics can be located at the radars (generally on the perimeter of the site) or can be remotely located at a central facility equipment room up to 50 miles away for ease of O&M and for security (requires broadband fiber network).

BELOW: HARRIER Utility tower installation

The HARRIER system is based on DeTect's MERLIN radar software and hardware platforms originally developed to detect and track low altitude, variable radar cross section (RCS), irregularly moving targets. HARRIER is not a modified aircraft or ship tracking system and all detection and tracking algorithms were specifically developed and programmed to 'look' for and follow targets with these complex characteristics to provide highly sensitive, reliable operation. DeTect's HARRIER radar processing software is user customizable and software definable to 'tune' the system to detect, track, and display only targets within the user desired target class based on a variety of parameters that include size, speed and track characteristics. Additionally, by using the S-band 3050 MHz frequency range, DeTect greatly minimizes the likelihood of frequency conflict with other systems such as air traffic control, weather radars, and communications networks.

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DOC# TDS-HARRIER ADLS-092116

Appendix C – IGIN-Enterprise to Field System Technical Data Sheet

Successful deployment of an ADLS may require that multiple diverse systems from different manufacturers should operate together in a seamless fashion. These may include some or all of the following technologies: Radar, FAA Obstruction Lights, Power Supply (e.g. solar, wind, grid, etc.), UPS, Telecommunications and HMI with applications that provide failsafe, alarming functionality, security and connectivity to other parties (e.g. customer facilities) – see Figure 1.

DigitaLogic's IGIN-EFS is a secure, open technology that enables the customer to have the freedom to choose the best-in-class vendors to fulfill the various roles required for a successful ADLS deployment.

IGIN-EFS is a general purpose, flexible, IT/OT platform that has been proven at many utilities and governmental organizations over almost two decades.

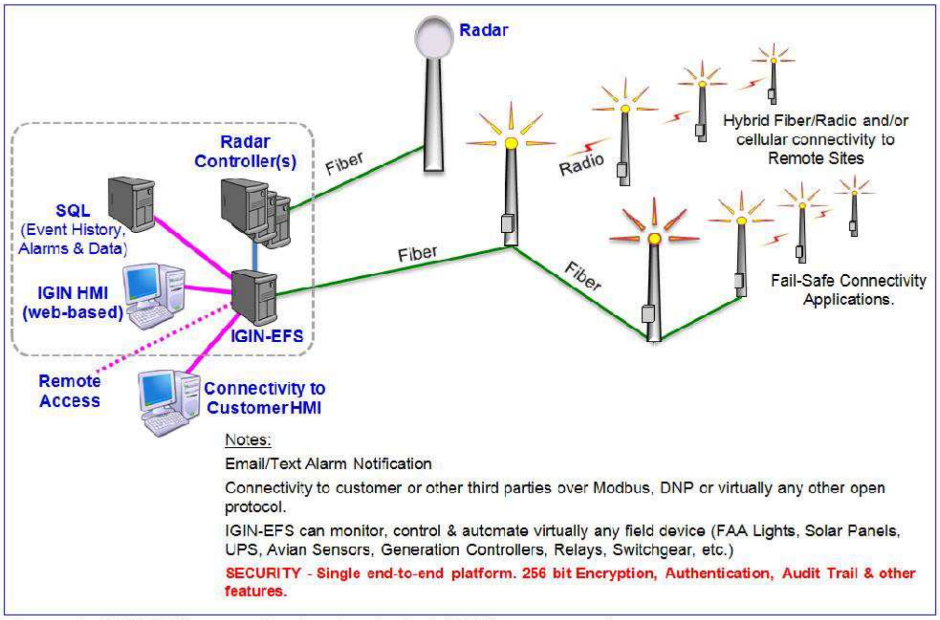


Figure 1: IGIN-EFS example showing typical ADLS components

IGIN-EFS provides:

- Telecommunications - the ability to communicate seamlessly over virtually any wired, fiber, wireless and/or cellular communication channels and creates secure a hybrid network (see Figure 2 & 3) with multiple links. Connectivity includes:
  - Enterprise Level Systems, Radar Controller(s), Customer HMI, etc.
  - Obstruction lights with and/or without ADLS control.
  - Third party solar systems and UPSs at remote sites.
- Security - Dynamic 256-bit encryption, time authentication, signature authentication, audit trail and other security features (end-to-end, encompassing any/all communication infrastructure).
- Scalability – the ability to start with a few sites and expand to many sites over time using different communications mediums (trunk voice, fiber, cellular, 900MHz, etc.)
- Reliability – Fail-Safe applications to detect communication failure for unsolicited connectivity and to switch the lights on until end-to-end communications are re-established and aircraft leave

the area. The Failsafe application accommodates different communication environments (TCP/IP, Serial, Fiber, Wireless) is able to automatically recover once end-to-end connectivity is re-established.

- Email/text notification - The system and automatically notifies utility personnel of alarms via email and/or text.
- Logging & Advanced communication diagnostics – The diagnostics include detailed logging at the front end and remote site, reporting communication events, reliability statistics, health of power supply and many other parameters on a real-time basis. This information is provided in order to simplify trouble-shooting and maintaining a reliable real-time wireless/cellular system on a pro-active basis.
- Ability to communicate
  - With any device from any lighting manufacturer and the solar power RTU/IED.
  - Over many different mediums (Cellular, Wireless, Fiber, Trunk Voice, etc.)
- Each Remote Site can report a large number of analogs and status points. IGIN is configured to only report specific points specified by the user.
- The ability to keep up with changing technology without becoming obsolete.
- Broadcast control to multiple devices (e.g. On/off to group of FAA Tower Warning Lights, Timesync, Dormant, Restart, Unsolicited AI/DI configuration.
- SCADA/HMI – Modern HMI capability enabling secure web-based browser viewing capability for computer, tablet smart phone, etc.

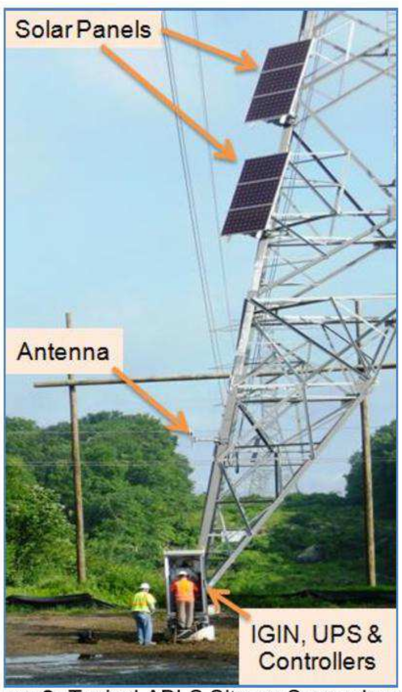
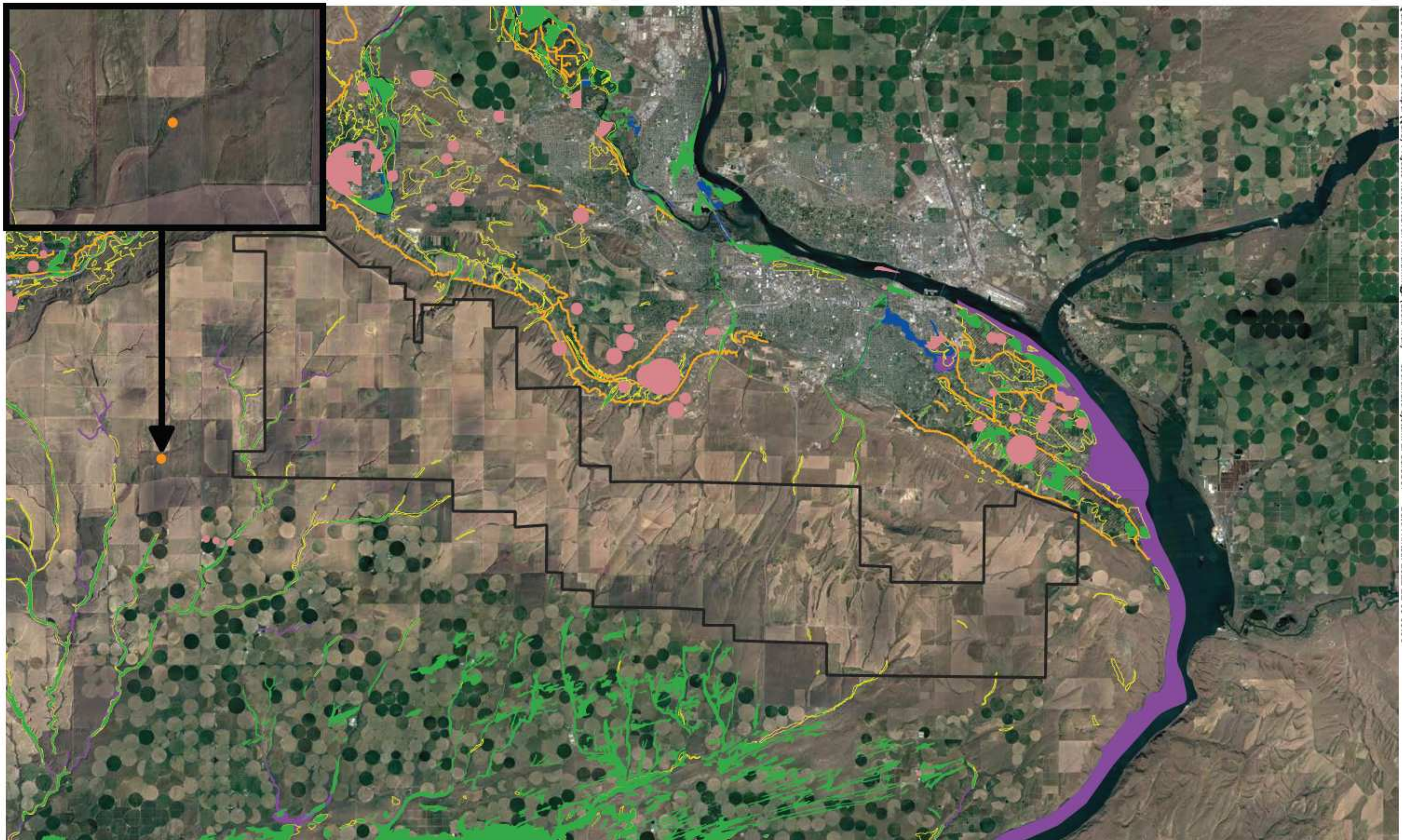


Figure 2: Typical ADLS Site on Susquehanna-Roseland Line on fiber/radio hybrid network.

Figure 3: Monitoring-only sites alongside NJ Turnpike, NJ on cellular/radio hybrid network.

Attachment 3
Gould Well Location



QGIS Path: L: GIS Sleeper (QGIS) Projects Horse Heaven Windfarm.qgz (Gould Well)   Coordinate System: EPSG:3857   Date Printed: 2022 12 09 09:00

- Proposed Project Boundary
- Gould Well
- Wellhead Protection Zone (10 Yr Time of Travel)
- Combined Hydrologic Soil Group A & Irrigated Ag
- Aqueducts, Canals, and Siphons
- Alluvial Soil
- 500 Year Flood Zone
- 100 Year Flood Zone

N

0   2.5   5 mi

Benton County Critical Aquifer Recharge Areas

Horse Heaven W nd Farm, LLC
Benton County, Wash ngton

Aspect CONSULTING	DEC 2022	BY: SSS/---	FIG NO. 1
	PRO NO 210258-A	REV BY: ---/---	

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Redaction Log

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Redaction Reasons by Page

Page	Reason	Description	Occurrences
3	13	Fish and wildlife: Sensitive fish and wildlife data. RCW 42.56.430	2

Redaction Date: 8/17/2023 12:52:20 PM

Redaction Log

Redaction Reasons by Exemption

Reason	Description	Pages (Count)
13	Fish and wildlife: Sensitive fish and wildlife data. RCW 42.56.430	3(2)