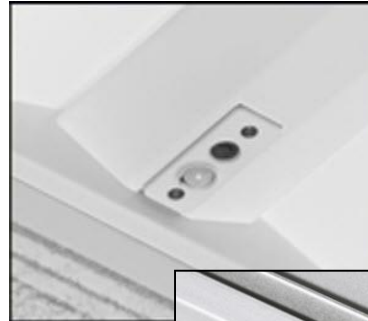


Commercial Advanced Lighting Control Demonstration and Deployment

2016 Building Technologies Office Peer Review



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

**Gabe Arnold, garnold@neep.org, NEEP &
DesignLights Consortium**

Jeff McCullough, jeff.mccullough@pnnl.gov, PNNL

Project Summary

Timeline:

Start date: **October 1, 2014**

Planned end date: **September 30, 2017**

Key Milestones

1. **Recommended EE Program Offerings; date**
2. **Completed Curricula and Training Implementation Plan; date**
3. **All Demonstration Project Installations Complete; date**

Budget:

Total Project \$ to Date (2/29/16):

- DOE: **\$223,756**
- Cost Share: **\$312,478**

Total Project \$: \$1,273,680

- DOE: **\$495,653**
- Cost Share: **\$778,027**

Key Partners: (list key partners)

Burlington Electric Department	Cape Light Compact
Efficiency Vermont	PSEG Long Island
EverSource MA and CT	NYSERDA
National Grid MA and RI	Pacific Gas and Electric
United Illuminating	Northwest EE Alliance
PNNL	Natural Resources Canada
Lighting Control Manufacturers	DLC Member Utilities

Project Outcome:

Accelerate the deployment and market adoption of Advanced Lighting Controls in Commercial Buildings by addressing market barriers that have limited their adoption.

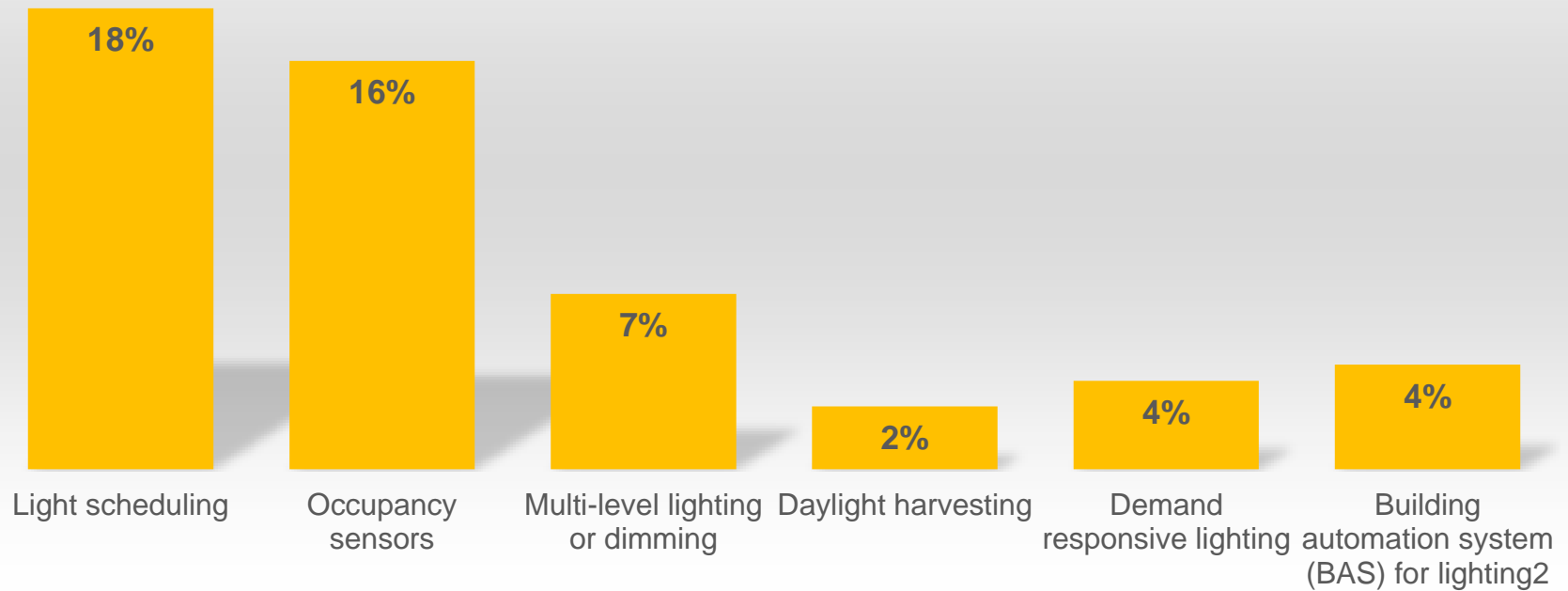
Problem Statement and Target Market

Problem Statement: Advanced Lighting Controls are an underutilized technology with low market penetration. The technology has low adoption due to several entrenched market barriers identified on slide 8.

Target Market and Audience: The target market is commercial buildings including Office, Retail, Education, Healthcare, Hospitality, Institutional, and Warehouse. Lighting in the commercial sector is responsible for approximately 350 TWh of energy use. If Advanced Lighting Controls were installed in all Commercial Buildings, approximately 100 TWh of energy could be saved, representing savings of \$10.4 billion annually.

Lighting Controls: A Missed Opportunity

Percent of Buildings with Control Strategy



Source: 2012 Commercial Buildings Energy Consumption Survey, US Energy Information Administration

Lighting Controls: A Missed Opportunity

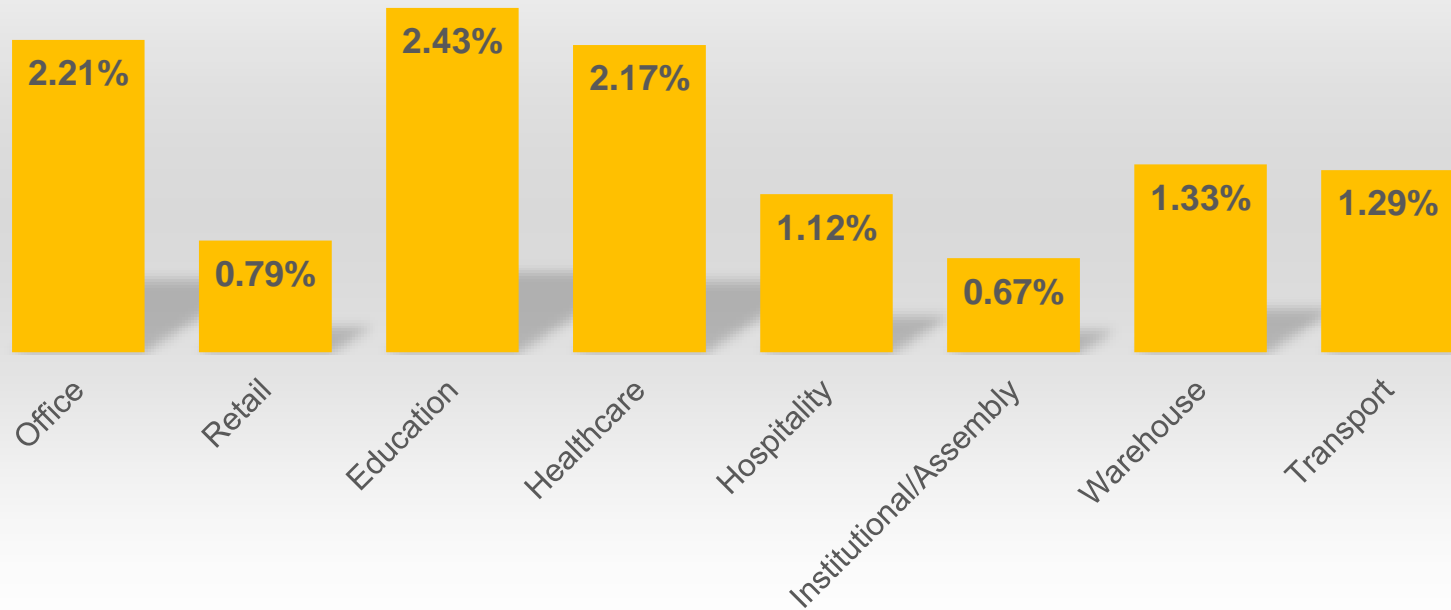
Northwest Region Indoor Lighting Power by Control Type and Building Type

Control Type	All (n=791)	Assembly (n=104)	Food Service (n=43)	Grocery (n=69)	Lodging (n=69)	Office (n=113)	Residential Care (n=68)	Retail (n=129)	School (n=72)	Warehouse (n=43)	Other (n=81)
Manual	2,087 73% ± 2%	279 77% ± 6%	53 87% ± 7%	63 72% ± 8%	121 86% ± 3%	448 68% ± 6%	118 91% ± 3%	447 68% ± 7%	139 61% ± 8%	211 83% ± 7%	208 76% ± 6%
Occupancy Sensor	224 8% ± 1%	27 7% ± 4%	0 0% ± 0%	1 1% ± 1%	1 1% ± 1%	73 11% ± 4%	3 2% ± 2%	12 2% ± 1%	34 15% ± 5%	43 17% ± 7%	32 12% ± 4%
EMS System	256 9% ± 2%	33 9% ± 4%	2 3% ± 4%	6 7% ± 5%	0 0% ± 1%	45 7% ± 4%	1 1% ± 1%	120 18% ± 5%	30 13% ± 6%	0 0% ± 0%	18 7% ± 4%
Dimming	24 1% ± 0%	10 3% ± 2%	4 7% ± 5%	0 0% ± 0%	4 3% ± 1%	1 0% ± 0%	1 0% ± 1%	0 0% ± 0%	1 0% ± 0%	1 0% ± 1%	2 1% ± 1%
Timeclock	74 3% ± 1%	7 2% ± 2%	0 0% ± 0%	2 2% ± 3%	2 1% ± 1%	31 5% ± 3%	1 0% ± 0%	28 4% ± 3%	2 1% ± 1%	0 0% ± 1%	2 1% ± 1%
Photocell	13 0% ± 0%	0 0% ± 0%	0 0% ± 1%	0 0% ± 0%	1 0% ± 0%	4 1% ± 1%	0 0% ± 0%	8 1% ± 1%	0 0% ± 0%	0 0% ± 0%	0 0% ± 0%
Other	126 4% ± 1%	5 1% ± 1%	0 0% ± 0%	5 6% ± 3%	0 0% ± 0%	50 8% ± 4%	0 0% ± 0%	33 5% ± 3%	24 10% ± 5%	0 0% ± 0%	9 3% ± 2%
None (Continuous)	54 2% ± 0%	3 1% ± 0%	1 2% ± 4%	11 12% ± 6%	13 9% ± 3%	6 1% ± 0%	6 5% ± 2%	10 2% ± 1%	0 0% ± 0%	0 0% ± 0%	4 2% ± 1%

Source: 2014 Commercial Building Stock Assessment, NEEA, Navigant, 2014

Lighting Controls: A Missed Opportunity

Penetration of Advanced Networked Lighting Controls in Commercial Buildings



Source: DLC, Navigant Consulting 2014

Lighting Controls: A Missed Opportunity

- **Utilization of Advanced Networked Controls within EE Programs less than 1%**

Energy Efficiency Program	Number of Projects with Advanced Networked Controls	Total Number of Lighting Projects	Utilization Rate
Efficiency Vermont (2011-2013)	<10	1,885	<0.5%
Cape Light Compact (2013)	0	291	0%
Burlington Electric Department (2013)	0	153	0%
PSEG Long Island (2013)	<25	5602	<0.5%

Adoption Barriers

- Knowledge and Experience
- Complexity
- Lack of Standardization
- High Costs
- Value Proposition
- EE Program Designs



NEEP's Commercial Advanced Lighting Controls Project

- A long-term, comprehensive project designed to address market barriers and increase adoption at scale
- Project outputs will be launched under NEEP's DesignLights Consortium (DLC) brand
- All activities are shown on this slide for information purposes, but only three are part of DOE scope and receive DOE funding



Demonstration Projects in Partnership with US DOE



Performance Spec and Qualified Products List



Training Programs for Designers and Installers



Advanced Control Savings Calculator



Support for Industry Standards



New Nationally Adopted EE Program Offerings

NEEP's Commercial Advanced Lighting Controls Project

Goal

Support energy efficiency administrators, industry, designers and other stakeholders with full scale deployment of Advanced Lighting Control technologies

Objectives

Create tools and resources to:

Reduce or eliminate market barriers that prevent large-scale adoption

Enable energy efficiency programs to scale up with the technology

Support industry, designers, and other market actors in scaling up with the technology and EE programs

Purpose and Objectives

Project Goal: Increase the adoption of Advanced Lighting Controls in Commercial Buildings by addressing barriers to adoption.

Project Activities: The project is long-term and includes many activities, some DOE funded, some not, all of which contribute to the achievement of the goal. The specific DOE funded activities and associated outputs include:

1. Ten demonstration projects and associated case studies
2. Development and implementation of scalable training programs for designers and installers (deployed in US and Canada via DLC)
3. Development and implementation of replicable, system-based energy efficiency program offerings for advanced controls (deployed in US and Canada via DLC)

Purpose and Objectives

Objectives of DOE Funded Activities:

- Identify and address market barriers that limit owner adoption of Advanced Lighting Controls (ALCs)
- Provide real building installation, performance, maintenance, and cost data, to improve use of ALCs by professionals that design, specify, install, commission and operate ALCs
- Reduce the total installed cost of ALCs
- Improve understanding of the benefits of ALCs
- Develop and deploy case studies to be used in utility and energy efficiency program marketing and outreach activities
- Develop and implement a national training program for designers and installers of ALCs
- Develop and deploy replicable, system-based utility and energy efficiency program offerings for ALC technology that can be adopted nationally

Goal Measurement

Near-term (during and up to 1yr after project) measured by:

- Adoption of project outputs by target audience.

Intermediate-term (1-3yr after project) measured by:

- Number of Advanced Lighting Control projects and associated savings seen by utility energy efficiency program partners compared to historical results.
- Updated market penetration study on slide XX compared to 2014 baseline.

Long-term (3+ yr after project) measured by:

- Number of projects and savings, same as above
- Updated market penetration study, same as above
- Additional market assessment(s) to measure progress as required

Approach

Stakeholder Engagement

Engage and develop strong partnerships with energy efficiency programs, the lighting controls industry, and other key stakeholders to provide guidance, support, and investment in project.

Training Programs

Use training to increase knowledge and experience of how to design, specify, install, commission, and operate ALCs. Target total installed cost barrier by improving installer familiarity of systems and educating designers on design and specification techniques to reduce cost.

Demonstration Projects

Provide data, proof of concept, case studies. Incorporate results into outreach, marketing, training programs, tools, and resources.

New Replicable, System-based EE Program Offerings

Reduced installed costs. Drive market to solutions that address market barriers.

Key Progress and Accomplishments in last year

Stakeholder Engagement

- 10 Advisory Committee Meetings with Project Participants
- DLC Stakeholder Meeting attended by 200+ Industry Stakeholders to discuss Project (Aug 2015)
- Advanced Lighting Control Summit attended by ~100 manufacturers and EE Programs to discuss project (Oct 2015)
- Multiple high-level speaking engagements on project

Training Programs

- Completed Training Framework and Curricula Recommendations (Sep 2015)
- Formed EE Program Working Group and Manufacturer Working Groups to guide Curriculum development and began Curriculum development (Nov 2015)

Demonstration Projects

- Selected first five demonstration sites, two installations now complete (Jan 2016), remaining three to commence installation soon
- Began Site Recruitment for second five sites

New Replicable, System-based EE Program Offerings

- Offering Complete Dec 2015. Currently developing energy savings assumptions to support it.

Other

- Completed Final Market Characterization and Technology to Market Strategy Report (May 2015)

Market Impact and Awards/Recognition

Market Impact

- DLC has obtained high levels of industry and utility engagement in developing and guiding this project that will result in large scale market impact once the project components are deployed.
- Currently there are no direct market impacts; the project is still in development phase.

Awards/Recognition

NEEP/DLC has presented on this project at many industry conferences over the past year, including but not limited to:

- Midwest Energy Solutions Conference
- ACEEE Market Transformation Symposium
- NEMA Lighting Systems Technical Forum
- Lightfair
- DOE Better Buildings Summit
- New England Energy Efficiency Expo
- DOE Connected Lighting Workshop
- DOE SSL Technology Development Workshop
- Strategies in Light
- DLC Annual Stakeholder Meeting
- DLC Advanced Lighting Control Summit

Project Integration and Collaboration

Project Integration: Strong engagement and partnership with stakeholders is essential to success and has been a cornerstone of the project since it began.

Partners, Subcontractors, and Collaborators: NEEP/DLC has deep engagements with industry and utilities through several committees that guide different components of the project. The project outputs will be deployed by DLC Member utilities whose logos are shown on slide 18.

Communications: A sample of conferences/meetings where the project has been presented is shown on slide 16.



Delivering more than power.™



Next Steps and Future Plans

Demonstration Projects

Complete installation of first five projects by June 30, 2016

Complete site selection for next five projects by June 30, 2016

Training Programs

Complete Curricula and Implementation Plan by June 30, 2016

Begin pilot training deployment Q3 and Q4, 2016

Full scale deployment in 2017

New Replicable, System-based EE Program Offerings

Pilot deployment in Q3 and Q4 2016

Full scale deployment in 2017

PNNL – Evaluation, Measurement and Verification

PNNL Role:

- Act as unbiased EM&V agent for NEEP CALC demonstration sites.

Activities:

- Develop technology-specific site questionnaire
- Participate in site selection process
- Develop technology- and site-specific M&V plans
- Deploy installer and end-user surveys
- Oversee M&V implementation
- Synthesize and report M&V data

Outcomes:

- 10, 2-page case studies: 5 completed in FY16, 5 completed in FY17
- Provide interim project progress snapshot: 6/24/16
- Final technical report: 3/30/17
- Presentations to relevant groups as directed.

PNNL – Evaluation, Measurement and Verification

EM&V Process

- Initial team conference call: NEEP (lead), supporting utility/sponsor, building owner/operator, controls manufacturer, PNNL principal investigator (PI) and M&V sub-contractor
- Technical kick-off Meeting (TKO)/Site Visit : NEEP, building owner/operator/representative, installing contractor, controls manufacturer, PNNL PI, M&V sub-contractor
- Develop Metering Plan: M&V sub-contractor contractor, PNNL PI
- Install M&V equipment: M&V sub-contractor
- Verify data integrity (automatic data collection): M&V sub-contractor/PNNL PI
- Remove M&V equipment: M&V sub-contractor
- Provide M&V report: M&V sub-contractor

EM&V - Floorplan and Metering Points



CONTROL EVALUATION AREA 3: HEARING ROOM

KEY

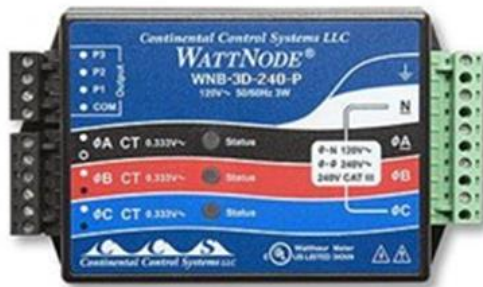


RI PUC
1ST FLOOR
LIGHTING MAP

- S EXISTING TOGGLE
- WDS PHILIPS SINGLE DIM SWITCH
- Ⓞ PHILIPS WIRELESS OCC SENSOR
- WS PHILIPS WIRELESS WALL SWITCH
- ## ROOM NUMBER
- ## EXISTING FT-C

- | | |
|----|----|
| A1 | C4 |
| B1 | C5 |
| B2 | D1 |
| B3 | D2 |
| B4 | D3 |
| C1 | D4 |
| C3 | I1 |
| | I2 |

EM&V - Electrical Panels



EM&V – Metering Points and Equipment

Table 2. Power Data Points To Be Collected

Metered Point ID	Panel ID	Circuit Breaker	Circuit Voltage	Phase	Circuit Amperage	Space Type	Load Description
M1	HP	13	120	1	20	Hall	3FL entry hall (RISE area 2)
M2	HP	9	120	1	20	Hall	1FL entry hall (RISE area 47)
M3	TP7	4,6	120	1	20	Open Office	3FL open office with corner private office (RISE area 11 with 10)
M4	A	4	120	1	20	Open Office	2FL open office with office (RISE area partial 27 with 21)
M5	A	6	120	1	20	Open Office	2FL open office (RISE area partial 27)
M6	A	8	120	1	20	Private Offices	2FL private office with closet (RISE areas 22, 23, 24, 25, with 26)
M7	A	10	120	1	20	Private Offices	2FL private office (RISE areas 16, 17, 18, 19)
M8	B	2	120	1	20	Hall	2FL entry hall (RISE area 15)
M9	B	4	120	1	20	Private Offices	2FL private office (RISE areas 37, 38, 39)
M10	B	6	120	1	20	Conference Room	2FL small conference (RISE area 43)
M11	B	10,12	120	1	20	Conference Room	2FL hearing room (RISE areas 35, 45)

Table 3. Daylight Loggers

Metered Point ID	Exposure	Location	Model #	Quantity
M17	North	Window	U12-012	1
M18	East	Window	U12-012	1
M19	South	Window	U12-012	1
M20	West	Window	U12-012	1
Total				4



Figure 1. Panel HP in Basement

EM&V – Metering Points and Equipment

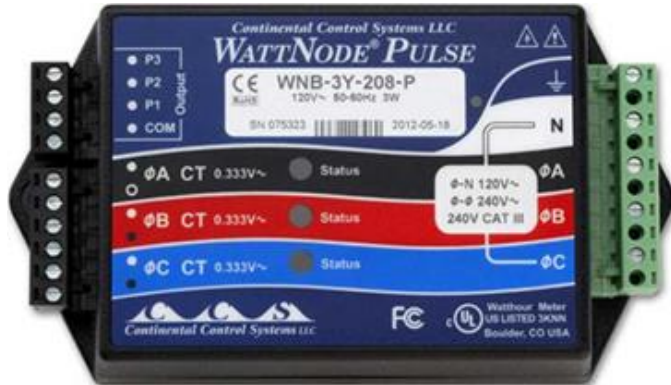


Table 4. Metering Equipment

Metered Point ID	Meter Model	CT Amperage	Meter Quantity	CT Quantity
M1	WNB-3Y-208-P3	5	1	1
M2	Same as M1	5	0	1
M3	WNB-3D-240-P	5	1	2
M4	WNB-3Y-208-P3	20	1	1
M5	Same as M4	20	0	1
M6	WNB-3Y-208-P3	20	1	1
M7	Same as M6	20	0	1
M8	WNB-3Y-208-P3	5	1	1
M9	Same as M8	5	0	1
M10	Same as M8	5	0	1
M11	WNB-3D-240-P	20	1	2
M12	WNB-3D-240-P	20	1	1
M13	WNB-3D-240-P	20	1	1
M14	WNB-3D-240-P	20	1	3
M15	WNB-3Y-208-P3	5	1	1
M16	Same as M15	5	0	1
Total			10	20

Table 5. Data Logging Equipment

Metered Point ID	Logger Model	Logger Qty.	Pulse Adapter Qty.
M1	RX-3000	1	1
M2	Same as M1	0	1
M3	RX-3000	1	1
M4	RX-3000	1	1
M5	Same as M4	0	1
M6	Same as M4	0	1
M7	Same as M4	0	1
M8	Same as M4	0	1
M9	Same as M4	0	1
M10	Same as M4	0	1
M11	Same as M4	0	1
M12	RX-3000	1	1
M13	RX-3000	1	1
M14	RX-3000	1	1
M15	RX-3000	1	1
M16	Same as M15	0	1
Totals		7	16



REFERENCE SLIDES

Project Budget

Project Budget: \$1,273,680

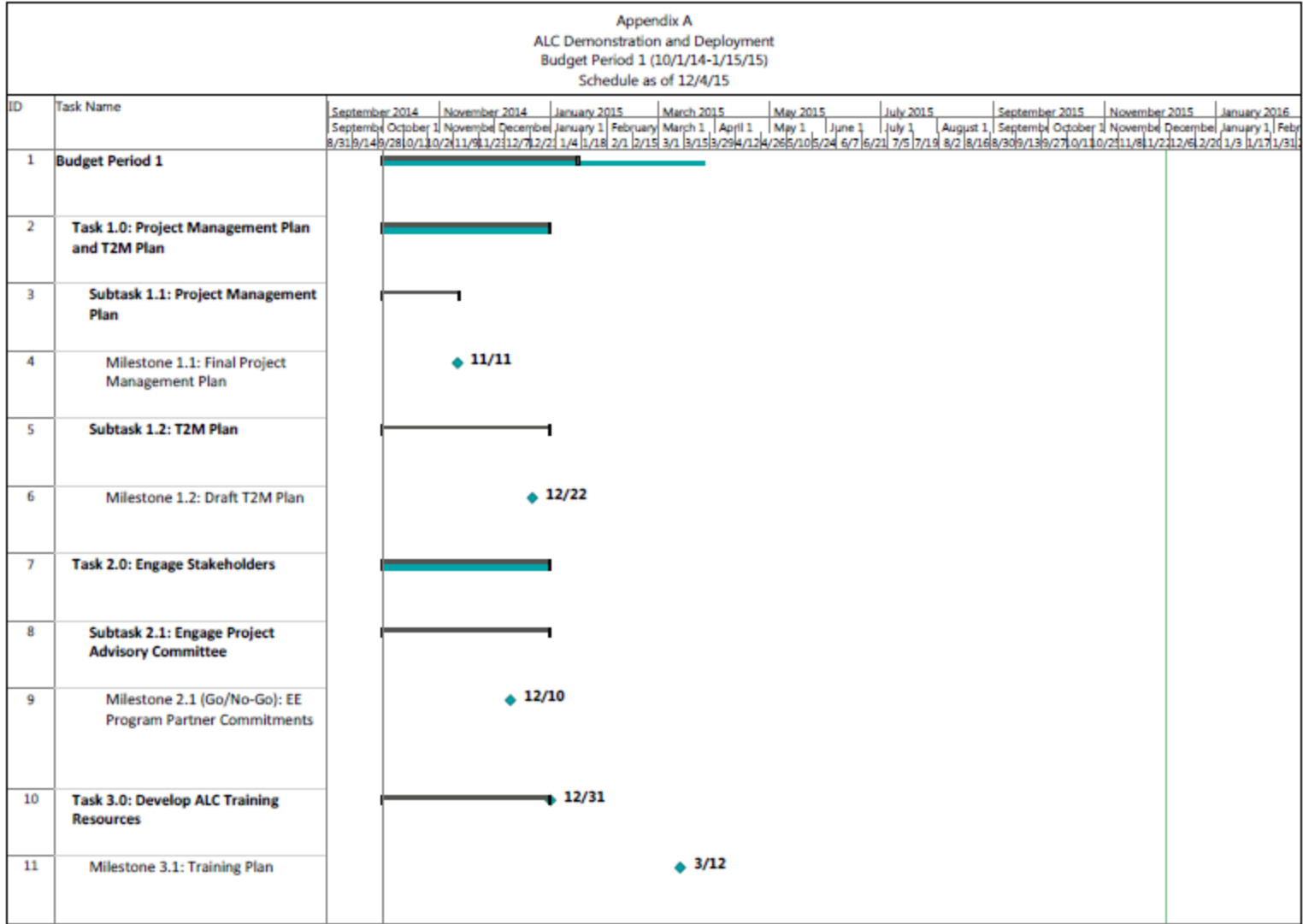
Variances: The Project Budget increased from \$1,152,139 as the actual cost of demonstration projects completed to date were higher than preliminary engineering estimates. NEEP provided additional cost share to cover the additional cost – no additional funds were requested of DOE.

Cost to Date: \$536,234, 42% of the project budget has been expended as of February 29, 2016

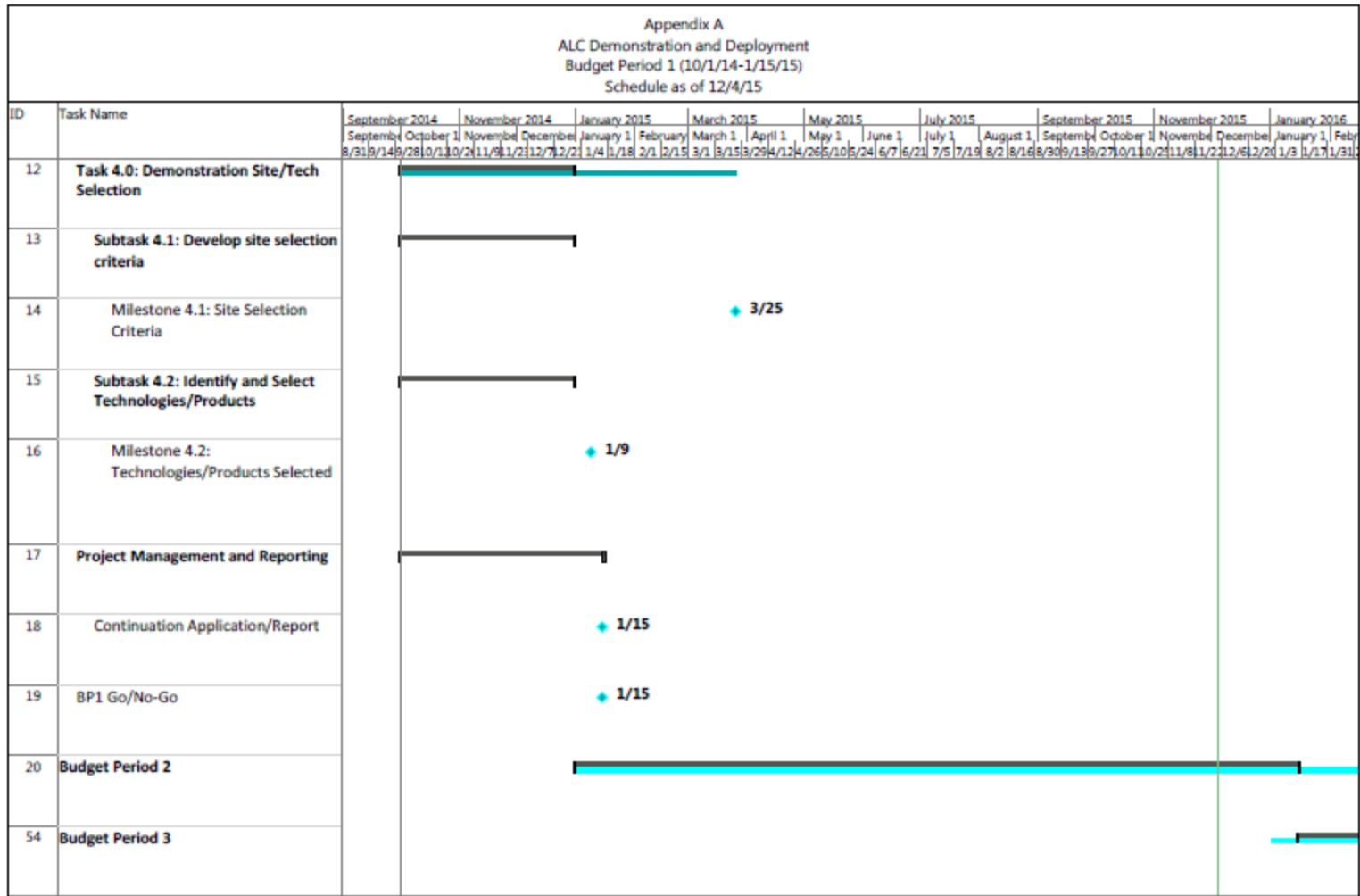
Budget History

10/1/14 – 12/31/14 (past)		1/1/15 – 12/31/15 (past)		1/1/16+ (planned)	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
\$28,921	\$28,922	\$124,867	\$171,541	\$341,865	\$577,564

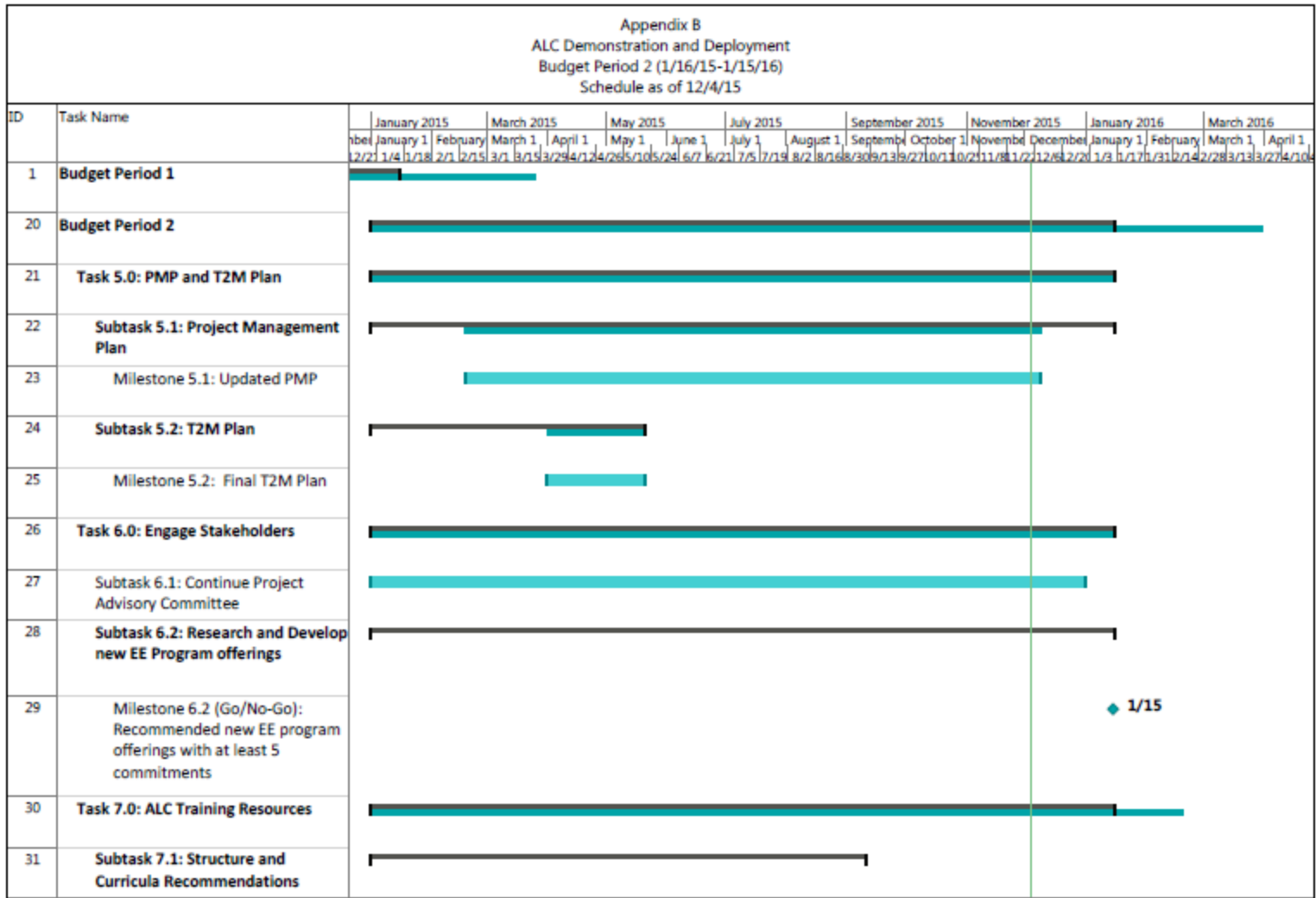
Budget Period 1 Past Work Gantt Chart – Page 1



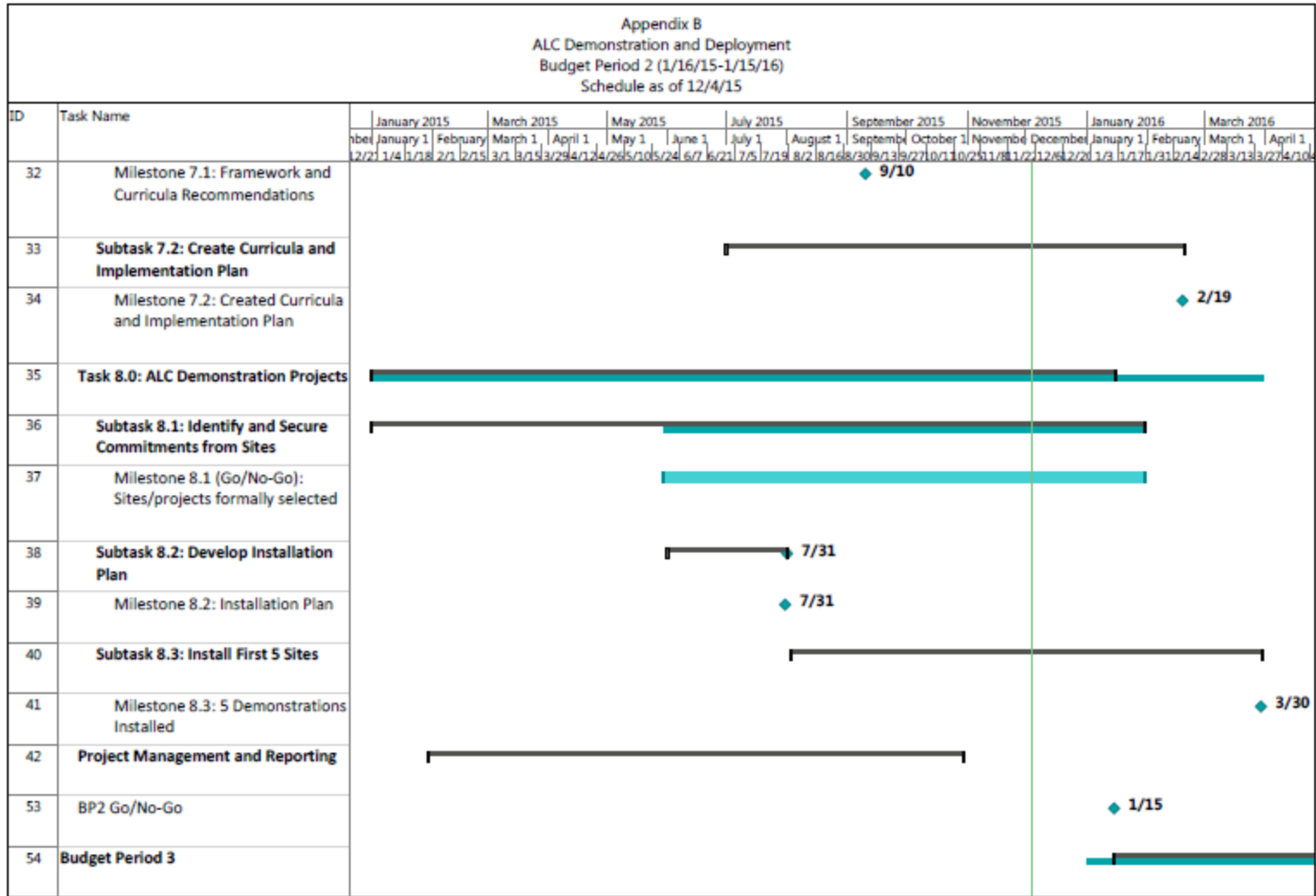
Budget Period 1 Past Work Gantt Chart – Page 2



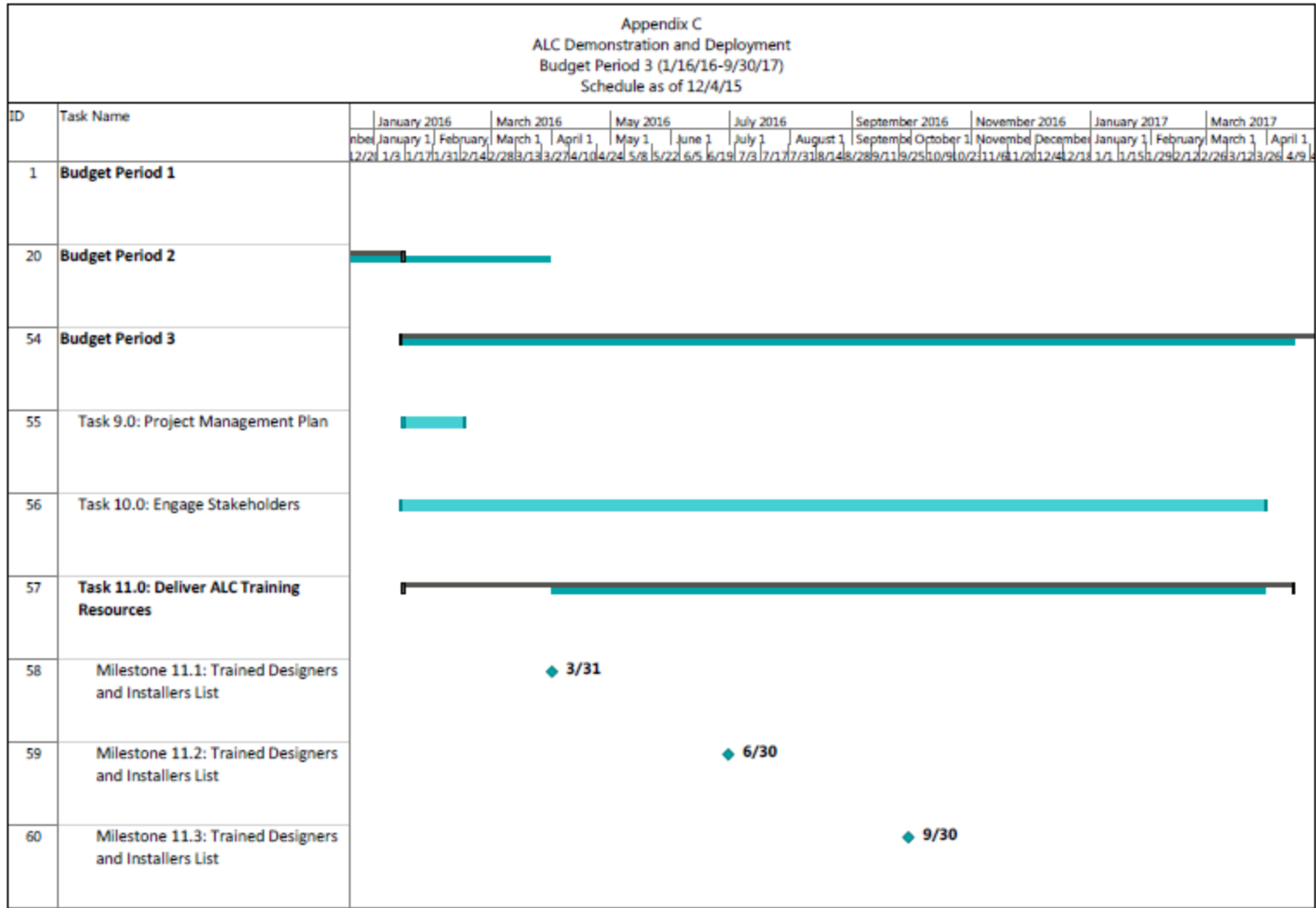
BP2 Current Work Gantt Chart – Page 1



BP2 Current Work Gantt Chart – Page 2



BP3 Future Work Gantt Chart – Page 1



BP3 Future Work Gantt Chart – Page 2

