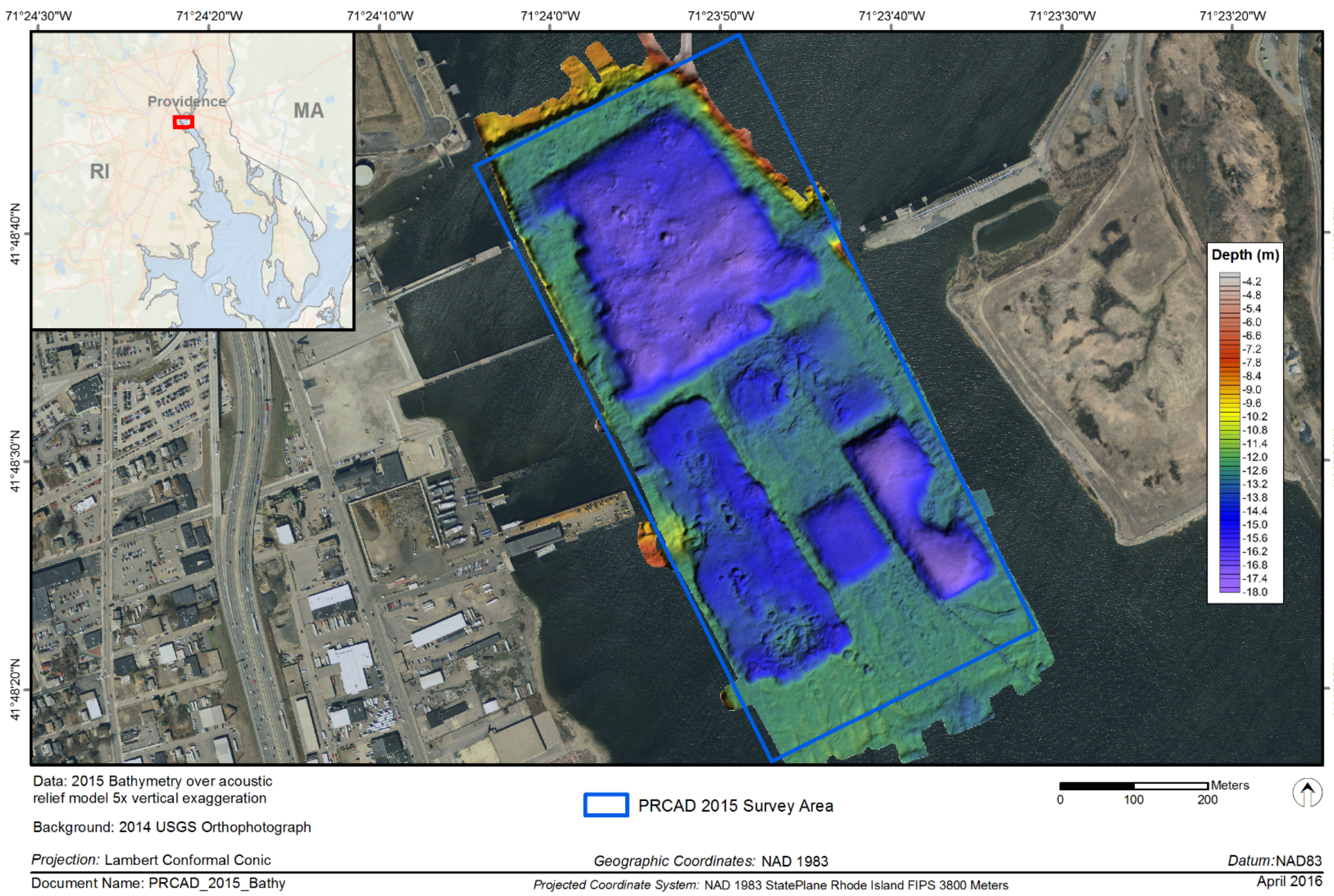
Data Summary Report for the Monitoring Survey at the Providence River CAD Cell Site - October 2015

Disposal Area Monitoring System DAMOS



Data Summary Report

DR 2015-03

February 2017

DAMOS

DISPOSAL AREA MONITORING SYSTEM

US Army Corps of Engineers ®

New England District

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<u>Note on units of this report</u>: As a scientific data summary, information and data are presented in the metric system. However, given the prevalence of English units in the dredging industry of the United States, conversions to English units are provided for general information in Section 1. A table of common conversions can be found in Appendix A.

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13. ABSTRACT

A monitoring survey was conducted at the Providence River Confined Aquatic Disposal (PRCAD) Cell Site in October 2015 as part of the U.S. Army Corps of Engineers (USACE) New England District (NAE) Disposal Area Monitoring System (DAMOS) Program.

The 2015 PRCAD Cell Site acoustic monitoring survey was designed as a limited confirmatory DAMOS survey of the active portion of the site to aid in site management for the upcoming 2015-16 dredging season.

The PRCAD Cells Site is located in Providence Harbor, just south of Fox Point and the confluence of the Providence and Seekonk Rivers, in Providence, Rhode Island (Figure 1-1). The CAD cell site is located 460 m (1,500 ft) south-southeast from the Hurricane Barrier in the Providence River (Figure 1-1). The CAD cells were constructed between May 2003 and January 2004 below the Providence Harbor channel in order to isolate dredged material not suitable for open ocean disposal generated from the Providence River and Harbor Maintenance Dredging Project (PRHMDP; ENSR 2008) as per the findings of the PRHMDP Final Environmental Impact Statement (USACE 2001).

The 2015 acoustic survey was designed as a confirmatory survey to provide a check on long-term stability and additional insight into the long-term consolidation of the PRCAD Cells. This was undertaken by completing a high-resolution multibeam bathymetric survey at the Providence River CAD Cell Site.

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TABLE OF CONTENTS

Page

LIST OF TABLES

LIST OF FIGURES

LIST OF ACRONYMS

ASCII	American Standard Code for Information Interchange
CCOM	Center for Coastal and Ocean Mapping
CI	Confidence interval
CTD	Conductivity-temperature-depth
DAMOS	Disposal Area Monitoring System
DGPS	Differential global positioning system
GIS	Graphic information system
GPS	Global positioning system
MBES	Multibeam Echo Sounder
MLLW	Mean lower low water
NAE	New England District
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NTRIP	Network transport of RTCM data over IP
PRCAD	Providence River Confined Aquatic Disposal Site
PRHMDP	Providence River and Harbor Maintenance Dredging Project
RTCM	Radio Technical Commission for Maritime Services
RTK	Real time kinematic GPS
SHP	Shapefile or geospatial data file
SOP	Standard Operating Procedures
TIF	Tagged image file
USACE	U.S. Army Corps of Engineers

1.0 INTRODUCTION

A monitoring survey was conducted at the Providence River Confined Aquatic Disposal (PRCAD) Cell Site in October 2015 as part of the U.S. Army Corps of Engineers (USACE) New England District (NAE) Disposal Area Monitoring System (DAMOS) Program. DAMOS is a comprehensive monitoring and management program designed and conducted to address environmental concerns surrounding the placement of dredged material at aquatic disposal sites throughout the New England region. An introduction to the DAMOS Program and PRCAD, including brief descriptions of previous dredged material disposal and site monitoring activities, is provided below.

1.1 Overview of the DAMOS Program

The DAMOS Program features a tiered management protocol designed to ensure that any potential adverse environmental impacts associated with dredged material disposal are promptly identified and addressed (Germano et al. 1994). For over 39 years, the DAMOS Program has collected and evaluated disposal site data throughout New England. Based on these data, patterns of physical, chemical, and biological responses of seafloor environments to dredged material disposal activity have been documented (Fredette and French 2004).

DAMOS monitoring surveys fall into two general categories: confirmatory studies and focused studies. The data collected and evaluated during these studies provide answers to strategic management questions in determining the next step in the disposal site management process to guide the management of disposal activities at existing sites, plan for use of future sites, and evaluate the long-term status of historic sites.

Confirmatory studies are designed to test hypotheses related to expected physical and ecological response patterns following placement of dredged material on the seafloor at established, active disposal sites. Two primary goals of DAMOS confirmatory monitoring surveys are to document the physical location and stability of dredged material placed into the aquatic environment and to evaluate the biological recovery of the benthic community following placement of dredged material. Several survey techniques are employed in order to characterize these responses to dredged material placement. Sequential acoustic monitoring surveys (including bathymetric, acoustic backscatter, and side-scan sonar data collection) are performed to characterize the height and spread of discrete dredged material deposits or mounds created at open water sites as well as the accumulation/consolidation of dredged material into confined aquatic disposal cells.

Sediment-profile (SPI) and plan-view (PV) imaging surveys are often performed in confirmatory studies to provide further physical characterization of the material and to support evaluation of seafloor (benthic) habitat conditions and recovery over time. Each type of data collection activity is conducted periodically at disposal sites and the conditions found after a defined period of disposal activity are compared with the long-term data set at specific sites to determine the next step in the disposal site management process (Germano et al. 1994).

Focused studies are periodically undertaken within the DAMOS Program to evaluate inactive or historic disposal sites and contribute to the development of dredged material placement and monitoring techniques. Focused DAMOS monitoring surveys may also feature additional types of data collection activities as deemed appropriate to achieve specific survey objectives, such as subbottom profiling, towed video, sediment coring, or grab sampling.

The 2015 PRCAD Cell Site acoustic monitoring survey was designed as a limited confirmatory DAMOS survey of the active portion of the site to aid in site management for the upcoming 2015-16 dredging season.

1.2 Introduction to the Providence River CAD Cell Site

The PRCAD Cells Site is located in Providence Harbor, just south of Fox Point and the confluence of the Providence and Seekonk Rivers, in Providence, Rhode Island (Figure 1-1). The CAD cell site is located 460 m (1,500 ft) south-southeast from the Hurricane Barrier in the Providence River (Figure 1-1). The CAD cells were constructed between May 2003 and January 2004 below the Providence Harbor channel in order to isolate dredged material not suitable for open ocean disposal generated from the Providence River and Harbor Maintenance Dredging Project (PRHMDP; ENSR 2008) as per the findings of the PRHMDP Final Environmental Impact Statement (USACE 2001).

A total of six cells were constructed as rectangular pits (or slightly trapezoidal in the cases of Cells 3AR and 6/7R) with dimensions at the sediment-water interface ranging from approximately 91 m × 91 m (300 ft × 300 ft) to 340 m × 347 m (1111 ft × 1118 ft), with depths of 20.7 to 30.2 m (70 ft to 100 ft) MLLW, with side slopes generally ranging from slightly steeper than 2:1 (horizontal: vertical) to slightly flatter than 3:1 (USACE 2012) (Figure 1-1). The original plan was for the CAD cells to be capped at the conclusion of the PRHMDP in 2005, however a bathymetric survey showed that the surface of each of the six cells remained well-depressed below the surrounding seafloor, with substantial additional capacity remaining in Cells 5R and 6/7R (Figure 1-2). The State of Rhode Island assumed management responsibility for all of the CAD cells to make full use of the remaining cell capacity for other, non-federal projects (USACE 2012).

1.3 Previous Monitoring Events at the Providence River CAD Cell Site

In October of 2009 a multibeam bathymetric survey of four New England CAD cells was conducted, including the PRCAD Cell Site. The objectives of the investigation were to document depths in and around the CAD cells, characterize cell morphology, and assess changes in morphology relative to available previous surveys. The 2009 bathymetric survey revealed the CAD cells as identifiable features on the harbor bottom (Figure 1-2). A comparison of the 2009 bathymetric data with available previous bathymetric data for each cell showed distinct changes that were dependent on the construction, disposal, and capping strategies for each cell or set of cells. The PRCAD cells remained uncapped at the time of the 2009 survey. A summary of previous investigations at the PRCAD Cell Site is presented in Table 1-1.

1.4 Recent Dredged Material Disposal Activity

Since the 2009 survey, approximately 135,600 m^3 (177,300 yd^3) of dredged material has been placed at the site (Table 1-2, Figure 1-3). All of this material was deposited at CAD Cell 6/7R.

1.5 2015 Survey Objectives

The 2015 acoustic survey was designed as a confirmatory survey to provide a check on long-term stability and additional insight into the long-term consolidation of the PRCAD Cells. This was undertaken by completing a high-resolution multibeam bathymetric survey at the Providence River CAD Cell Site.

Table 1-1.

Summary of Previous Investigations at the Providence River CAD Cell Site (USACE 2012)

Date	Period	Study Type	Reference
September 2003	Cell Construction	Plume monitoring	Reine and Clarke, unpublished
May-September 2003	Cell Disposal	Plume and water quality monitoring	USACE submittals to RI Dept. of Environmental Management
2003-2005	Post-construction; Cell Disposal	Bathymetric surveys	ENSR 2008
May 2005	Post-disposal	Bathymetric surveys	ENSR 2008
October 2009	Baseline for longer term study	Bathymetric surveys	USACE 2012

Table 1-2.

Estimated Volume of Dredged Material Placed at PRCAD
between 2009 and 2015 as Reported by USACE

Disposal Season	Cell	Volume (m^3)	Volume (yd^3)
2014-2015	6/7R	19,903	26,032
2013-2014	6/7R	72,329	94,603
2011-2012	6/7R	27,432	35,880
2010-2011	6/7R	7,614	9,959
2009-2010	6/7R	8,281	10,831
	Total	**135,559**	**177,305**

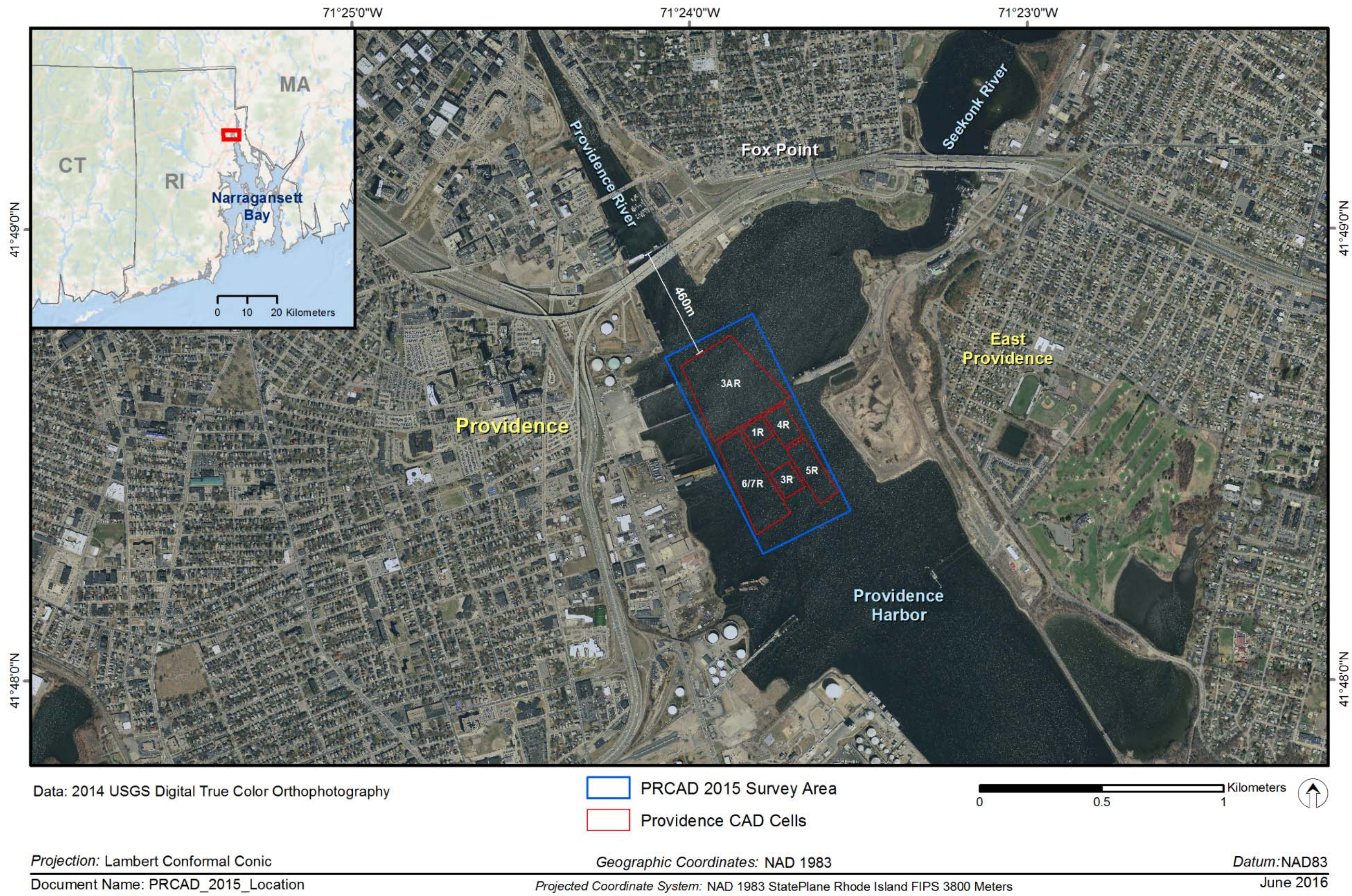

Figure 1-1. Location of the Providence River Confined Aquatic Disposal (PRCAD) Cell Site

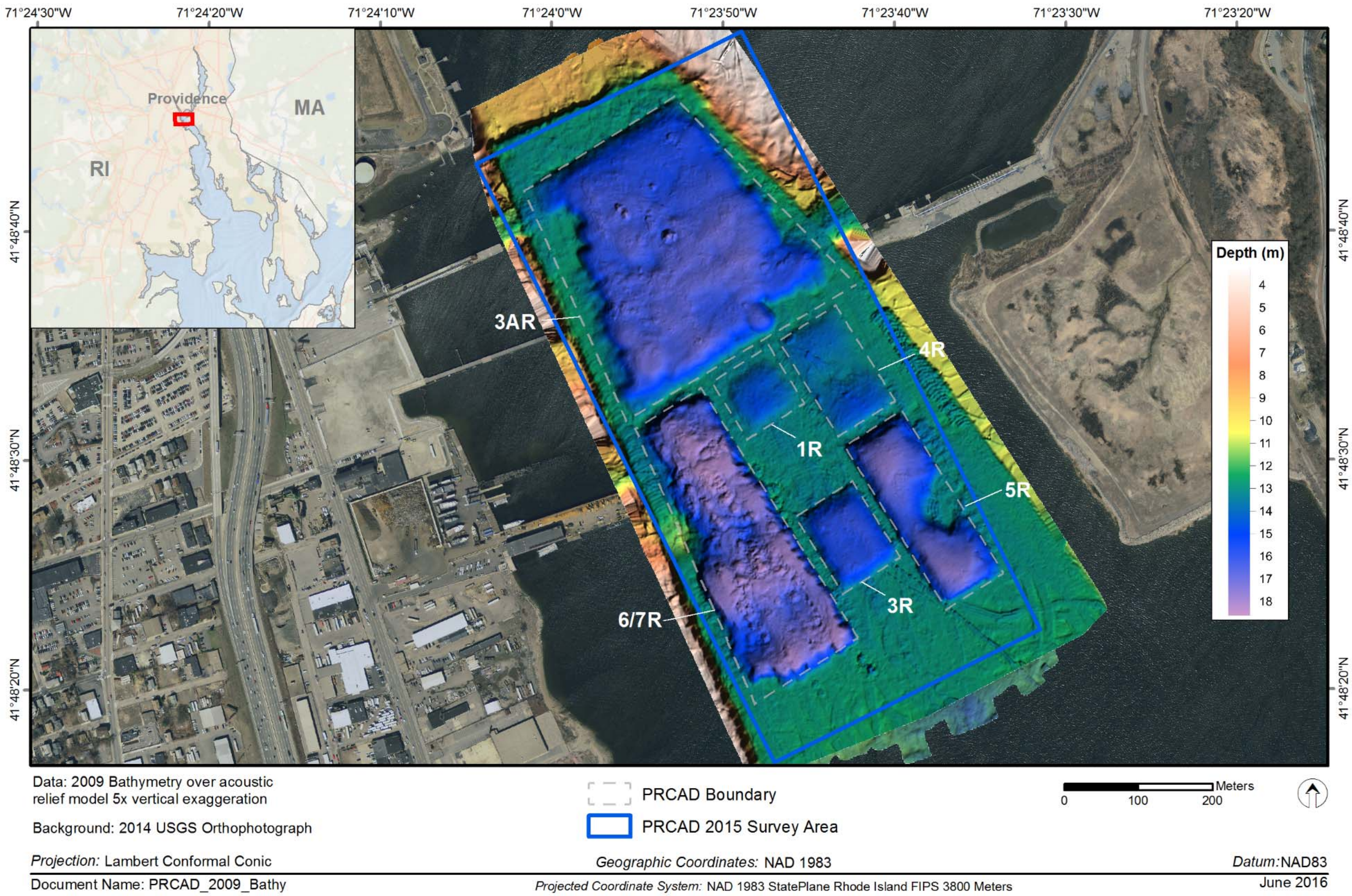

Figure 1-2. Bathymetric contour map of PRCAD Cells – October 2009

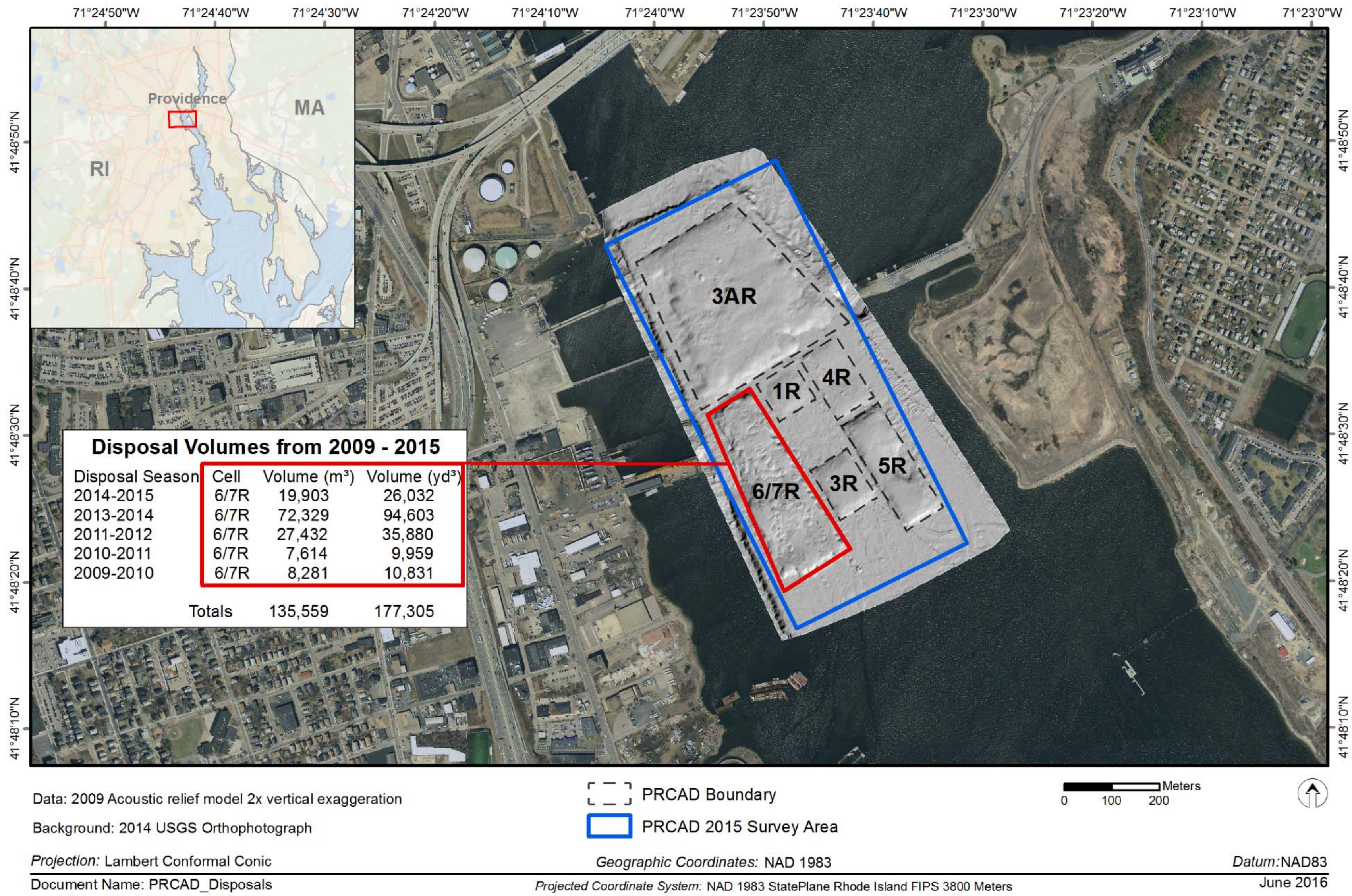

Figure 1-3. Location of reported disposal events at PRCAD Cell 6/7R: 2009 - 2015

2.0 METHODS

The October 2015 survey at PRCAD Cells was conducted by a team of investigators from DAMOSVision (CoastalVision and CR Environmental) aboard the 55-foot R/V *Jamie Hanna*. The acoustic survey was conducted on 24 October 2015. An overview of the methods used to collect, process, and analyze the survey data is provided below. Detailed Standard Operating Procedures (SOPs) for data collection and processing are available in the Quality Assurance Project Plan for the DAMOS Program (Battelle 2015).

2.1 Navigation and On-Board Data Acquisition

Navigation for the acoustic survey was accomplished using a Hemisphere VS-330 Real-time kinematic Global Positioning System (RTK GPS) which received base station correction through the Keynet NTRIP broadcast. Horizontal position accuracy in fixed RTK mode was approximately 2 cm. A dual-antennae Hemisphere VS110 differential GPS (DGPS) was available if necessary as a backup. The GPS system was interfaced to a desktop computer running HYPACK MAX® hydrographic survey software. HYPACK MAX® continually recorded vessel position and GPS satellite quality and provided a steering display for the vessel captain to accurately maintain the position of the vessel along pre-established survey transects and targets. Vessel heading measurements were provided by an IxBlue Octans III fiber optic gyrocompass.

2.2 Acoustic Survey

The acoustic survey included bathymetric, backscatter, and side-scan sonar data collection. The bathymetric data provided measurements of water depth that, when processed, were used to map the seafloor topography. Backscatter and side-scan sonar data provided images that supported the characterization of surface sediment texture and roughness. Each of these acoustic data types is useful for assessing dredged material placement and surface sediment features.

2.2.1 Acoustic Survey Planning

The acoustic survey featured a high spatial resolution survey of the PRCAD Cell Site. DAMOSVision hydrographers coordinated with USACE NAE scientists and reviewed alternative survey designs. For PRCAD Cell Site, a 400 × 900 m area was selected. Hydrographers obtained site coordinates, imported them to graphic information system (GIS) software, and created maps to aid planning. Base bathymetric data from previous DAMOS surveys were used to calculate the transect separation required to obtain full bottom coverage using an assumed beam angle limit of 90-degrees (45 degrees to port, 45 degrees to starboard). Transects spaced 17 m apart and cross-lines spaced 100 m apart were created to meet conservative beam angle constraints (Figure 2-1). The proposed survey area and design were then reviewed and approved by NAE scientists.

2.2.2 Acoustic Data Collection

Data layers generated by the survey included bathymetric, acoustic backscatter, and side-scan sonar and were collected using an R2Sonic 2022 broadband multibeam echo sounder (MBES). This 200-400 kHz system forms up to 256 1-2° beams (frequency dependent) distributed equiangularly or equidistantly across a 10 - 160° swath. The MBES system was operated using a transmit frequency of 249 kHz to facilitate comparisons with previous DAMOS survey data while maximizing bathymetric resolution. The MBES transducer was mounted amidships to the port rail of the survey vessel using a high strength adjustable boom. The primary GPS antenna was mounted on the transducer boom. The transducer depth below the water surface (draft) and antenna height were checked and recorded at the beginning and end of data acquisition, and the draft was confirmed using the "bar check" method.

An IxBlue Octans III motion reference unit (MRU) was interfaced to the MBES topside processor and to the acquisition computer. Precise linear offsets between the MRU and MBES were recorded and applied during acquisition. Depth and backscatter data were synchronized using pulse-per-second timing and transmitted to the HYPACK MAX® acquisition computer via Ethernet communications. Several patch tests were conducted during the survey to allow computation of angular offsets between the MBES system components.

The system was calibrated for local water mass speed of sound by performing sound velocity profile (SVP) casts at frequent intervals throughout the survey day using an AML, Inc. Minos-X profiling instrument.

2.2.3 Bathymetric Data Processing

Bathymetric data were processed using HYPACK HYSWEEP® software. Processing components are described below and included:

- Adjustment of data for tidal elevation fluctuations
- Correction of ray bending (refraction) due to density variation in the water column
- Removal of spurious points associated with water column interference or system errors
- Development of a grid surface representing depth solutions
- Statistical estimation of sounding solution uncertainty
- Generation of data visualization products

Tidal adjustments were accomplished using RTK GPS. Water surface elevations derived using RTK were adjusted to Mean Lower Low Water (MLLW) elevations using NOAA's VDATUM Model. Processed RTK tide data were successfully ground-truthed against a data series acquired at NOAA's Providence Tide Station (#8454000).

Correction of sounding depth and position (range and azimuth) for refraction due to water column stratification was conducted using a series of four sound-velocity profiles acquired by the survey team. Data artifacts associated with refraction remain in the bathymetric surface model at a relatively fine scale (generally less than 5 to 10 cm) relative to the survey depth.

Data acquired in the disposal site portion of the survey area were filtered to accept only beams falling within an angular limit of 55° to minimize refraction artifacts. Spurious sounding solutions were rejected based on the careful examination of data on a sweep-specific basis.

As indicated earlier, the R2Sonics 2022 MBES system was operated at 249 kHz. At this frequency the system has a published beam width of 1.75°. Assuming a mean depth of 13.5 m and a maximum beam angle of 55°, the average diameter of the beam footprint was calculated at approximately 0.5 × 0.5 m (0.25 m^2). Data were reduced to a cell (grid) size of 1.0 × 1.0 m, acknowledging the system's fine range resolution while accommodating beam position uncertainty. This data reduction was accomplished by calculating and exporting the average elevation for each cell in accordance with USACE recommendations (USACE 2013).

Statistical analysis of data as summarized on Table 2-1 showed negligible tide bias and vertical uncertainty substantially lower than values recommended by USACE (2013) or NOAA (2015). Note that the most stringent National Ocean Service (NOS) standard for this project depth (Special Order 1A) would call for a 95th percentile confidence interval (CI) of 0.28 m at the maximum site depth (17.4 m) and 0.27 m at the average site depth (13.5 m).

Reduced data were exported in ASCII text format with fields for Easting, Northing, and MLLW Elevation (meters). All data were projected to the Rhode Island State Plane FIPS 3800, NAD83 (metric). A variety of data visualizations were generated using a combination of ESRI ArcMap (V.10.1) and Golden Software Surfer (V.13). Visualizations and data products included:

- ASCII data files of all processed soundings including MLLW depths and elevations
- Contours of seabed elevation (20-cm, 50-cm and 1.0-m intervals) in a geospatial data file (SHP) format suitable for plotting using GIS and computer-aided design software
- 3-dimensional surface maps of the seabed created using 5× vertical exaggeration and artificial illumination to highlight fine-scale features not visible on contour layers delivered in grid and tagged image file (TIF) formats, and
- An acoustic relief map of the survey area created using 5× vertical exaggeration, delivered in georeferenced TIF format.

2.2.4 Backscatter Data Processing

Backscatter data were extracted from cleaned MBES TruePix formatted files then used to provide an estimation of surface sediment texture based on seabed surface roughness. Mosaics of backscatter data were created using HYPACK®'s implementation of GeoCoder software developed by scientists at the University of New Hampshire's NOAA Center for Coastal and Ocean Mapping (UNH/NOAA CCOM). A seamless mosaic of unfiltered backscatter data was developed and exported in grayscale TIF format. Backscatter data were also exported in ASCII format with fields for Easting, Northing, and backscatter (dB). A Gaussian filter was applied to backscatter data to minimize nadir artifacts and the filtered data were used to develop backscatter values on a 50-cm grid. The grid was delivered in ESRI binary GRD format to facilitate comparison with other data layers.

2.2.5 Side-Scan Sonar Data Processing

Side-scan sonar data were processed using Chesapeake Technology, Inc. Sonar Wiz software to generate a database of images that maximized both textural information and structural detail. Mosaics of side-scan data were created using raw and gain-adjusted data to facilitate detailed inspection of sonar imagery using a resolution of 0.1 m per pixel.

2.2.6 Acoustic Data Analysis

The processed bathymetric grids were converted to rasters, and bathymetric contour lines and acoustic relief models were generated and displayed using GIS. The backscatter mosaics and filtered backscatter grid were combined with acoustic relief models in GIS to facilitate visualization of relationships between acoustic datasets. This is done by rendering images and color-coded grids with sufficient transparency to allow three-dimensional acoustic relief model to be visible underneath.

Table 2-1.

Accuracy and Uncertainty Analysis of Bathymetric Data

Survey Date(s)	Quality Control Metric	Results (m) Mean	95% Uncertainty	Range		
10/24/2015	Cross-Line Swath Comparisons	0.01	0.10			
	Within Cell Uncertainty	0.06	0.14	0.00	-	3.18*
	Beam Angle Uncertainty (0 - 55°)	0.02	0.12	0.10	-	0.14

* The within cell uncertainty was higher than normal likely due to the MBES picking up on a piling.

Notes:

1. The mean of cross-line nadir and full swath comparisons are indicators of tide bias.
2. 95% uncertainty values were calculated using the sums of mean differences and standard deviations expressed at the 2-sigma level.
3. Within cell uncertainty values include biases and random errors.
4. Beam angle uncertainty was assessed by comparing cross-line data (55-degree swath limit) with a reference surface created using mainstay transect data.
5. Swath and cell based comparisons were conducted using 1 m × 1 m cell averages. These analyses do not exclude sounding variability associated with terrain slopes

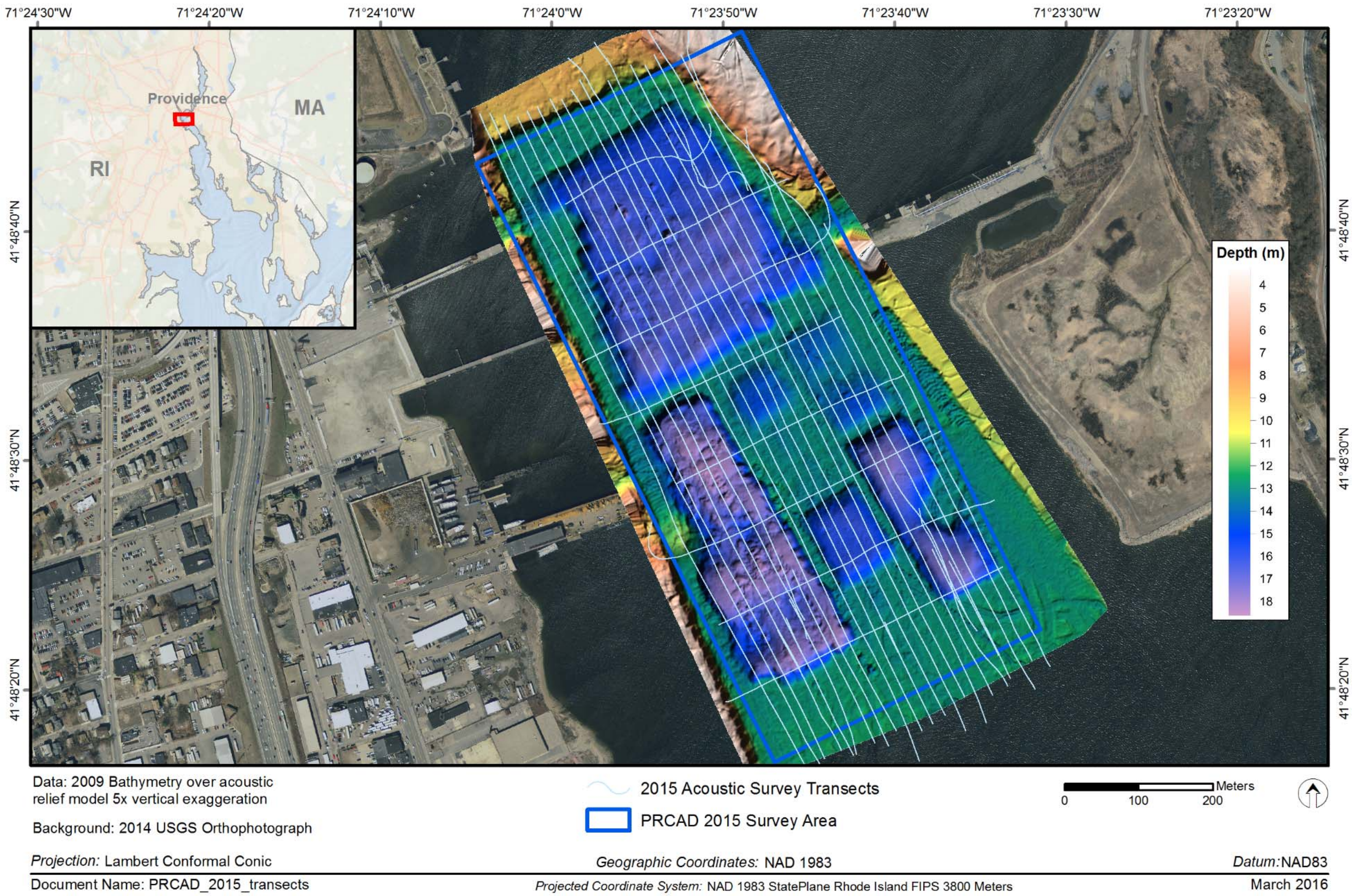

Figure 2-1. PRCAD acoustic survey area and tracklines

3.0 RESULTS

3.1 Acoustic Survey

An acoustic survey was conducted in October 2015 to characterize seafloor topography and surface features over the entire group of PRCAD cells in the Providence Harbor.

3.1.1 Bathymetry

The bathymetry of the PRCAD cells, as surveyed in 2015, revealed the distinct topographic features of the CAD cells (Figure 3-1). The PRCAD cells were distinguished from the surrounding channel depths as topographic depressions and were generally 4 to 6 m below the channel depth of 12.5 m. CAD Cells 3AR and 5R were the deepest, roughly 6 m below channel depth (Figure 3-1).

Cells 1R and 4R were less well-defined than the other cells, each approximately 3 m below the surrounding bottom, with some areas at the same depths as the surrounding channel. CAD Cell 3R was approximately 150 m along-channel by 125 m across-channel with a uniform bottom depressed approximately 3 m below the channel bottom. CAD Cell 3AR covered an approximate area of 325 m along-channel by 250 m across-channel, and was the largest of the PRCAD cells with a rough surface containing small pits and mounds. CAD Cell 5R covered an approximate area of 250 m along-channel by 100 m across-channel, and the bottom appeared fairly uniform, except for an area on the eastern side at ambient depth (as reported in 2005, ENSR 2008). CAD Cell 6/7R was approximately 325 m along-channel by 125 m across-channel, and was depressed by approximately 3 m. The southern portion had a mound with a peak close to ambient depths.

Multibeam bathymetric data rendered as an acoustic relief model (hill-shading) provided a detailed representation of the small-scale site topography (Figure 3-2). CAD Cells 1R and 4R were not well-defined but could been seen as irregular depressions which contrast with the surrounding channel bottom. CAD Cells 3AR and 6/7R, the two largest cells, were distinctive with a depressed area that contained clear evidence of dredged material disposal (small pits and mounds) that contrasted with the fairly uniform surface of CAD Cells 3R and 5R.

3.1.2 Acoustic Backscatter and Side-Scan Sonar

Unfiltered backscatter imagery of the PRCAD cells indicated variable patterns of bottom types throughout the survey area. Strong backscatter returns that indicate rougher or coarse grain sediment were evident in CAD Cells 1R, 3R and 6/7R which occur in the southwest portion of the survey area (Figure 3-3). Strong backscatter was also apparent at several smaller isolated areas on either side of CAD Cell 3AR. Weaker returns were found at the large CAD Cell 3AR in the northern part of the survey area, and to the east southeast of the survey area at CAD Cells 4R and 5R. Weaker returns indicated finer-grained sediment which was typical of the ambient conditions observed in the surrounding channel.

Filtered backscatter, which presents a quantitative assessment of surface characteristics independent of slope effects, showed that the weakest sonar returns (-37 to -40 dB), indicating softer sediment, occurred in small pockets in the center of the large northern CAD Cell 3AR, and in pockets to the east southeast of CAD Cells 4R and 5R (Figure 3-4). The majority of the survey area, including both the topographic depressions of the CAD cells, and ambient channel bottom had moderate backscatter returns (-31 to -34 dB). Stronger backscatter returns (-20 to -26 dB) were observed in the center of the survey area in the northern portion of CAD Cell 6/7R, Cell 1R, and in the area between Cells 1R and 3R. These strong signatures were interspersed amongst moderate backscatter returns. There was also a strong backscatter return in two isolated pockets on either side of CAD Cell 3AR, and the strongest backscatter returns (<-18 dB) were observed in the topographic relief at the southern end of CAD Cell 6/7R suggesting the presence of coarser sediments.

Side-scan sonar results also provided a clear representation of disposal activity over large portions of the site. Side-scan results confirmed observations from the backscatter results, but with additional information and some distinct differences (Figure 3-5). The side-scan sonar results had a higher resolution and were more responsive to minor topographic relief at the southern end of CAD Cell 6/7R (Figure 3-6) and irregular surface of Cells 1R and 4R were apparent as features with stronger returns depicted in light gray (Figure 3-7).

3.1.3 Comparison with Previous Bathymetry

The multibeam bathymetric survey data from 2015 (Figure 3-1) was compared with the multibeam bathymetric survey data collected in October of 2009 (Figure 1-2). A subtraction of the bottom depths in the 2009 survey from the 2015 depths captured the apparent changes in bathymetry since the 2009 survey (Figure 3-8). The most notable difference was the accumulation of material in CAD Cell 6/7R in the southwestern portion of the survey area, with as much as 5.5 m of accumulation since 2009. These depth changes were the largest observed in the survey area and depth decreases of greater than 5 m occurred at the majority of CAD Cell 6/7R. The large positive changes in depth difference at CAD Cell 6/7R were to be expected as this area was targeted for disposal between the 2009 and 2015 surveys (Figure 1-3). The total volume in 6/7R divided by the area of 6/7R equals a uniform accumulation of about 3.3 m (Appendix B). There were subtle increases (<1 m) in the accumulation of material on the bottom in areas immediately adjacent to CAD Cell 6/7R, in and around Cells 3AR and 3R, and in portions of Cell 5R. There were decreases in material, likely from consolidation, at a few places in the survey area, most notably in the area of CAD Cells 1R and 4R, where negative depth differences of 0.3 to 0.8 m were observed. The majority of CAD Cell 3AR showed no changes in depth between 2009 and 2015, and the topographical features for much of this area appear to be relics of activity before the 2009 survey. All six cells remain depressed below the surrounding seafloor, with significant additional capacity remaining in cells 3AR and 5R.

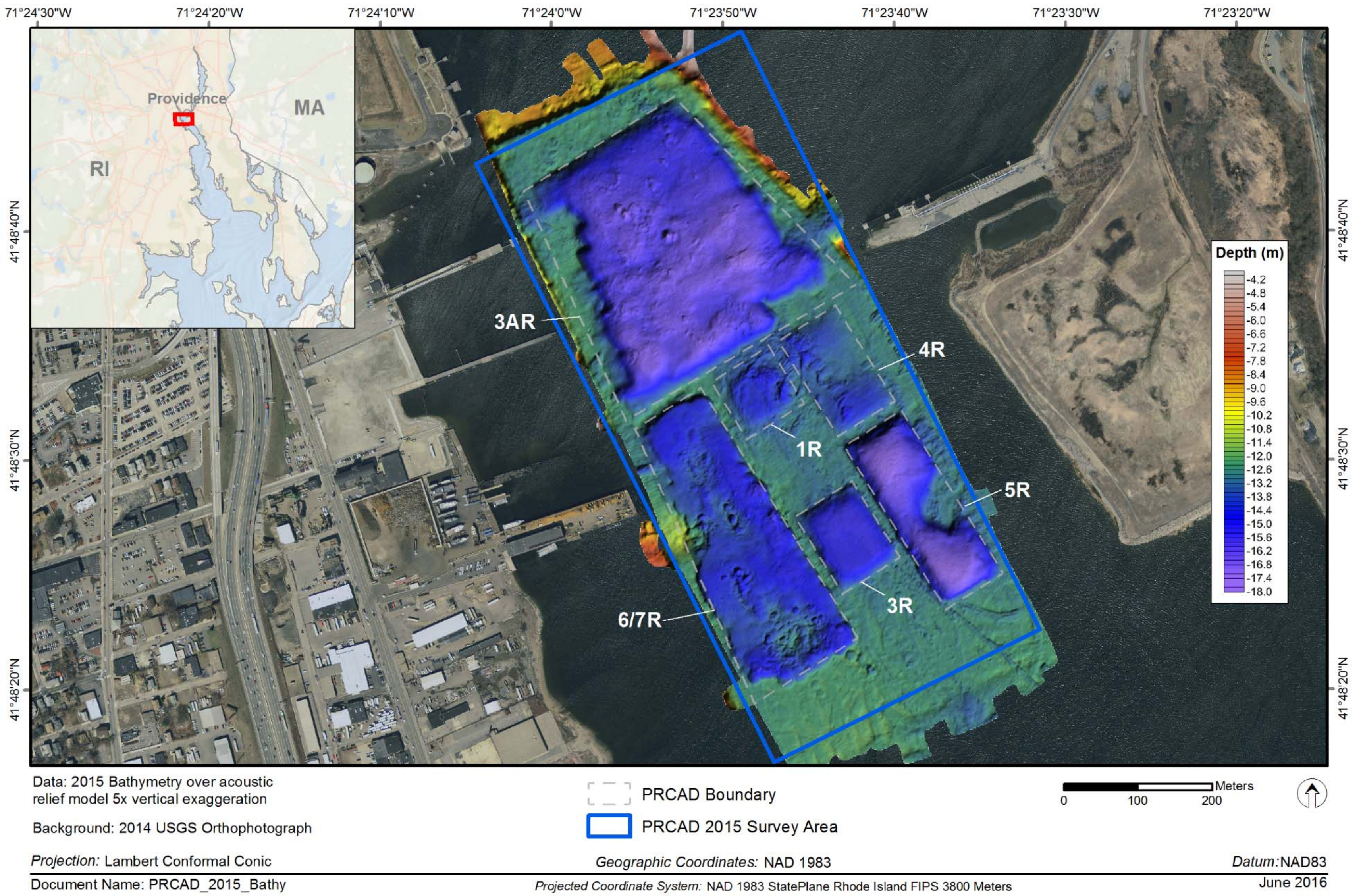

Figure 3-1. Bathymetric depth data map of PRCAD – October 2015

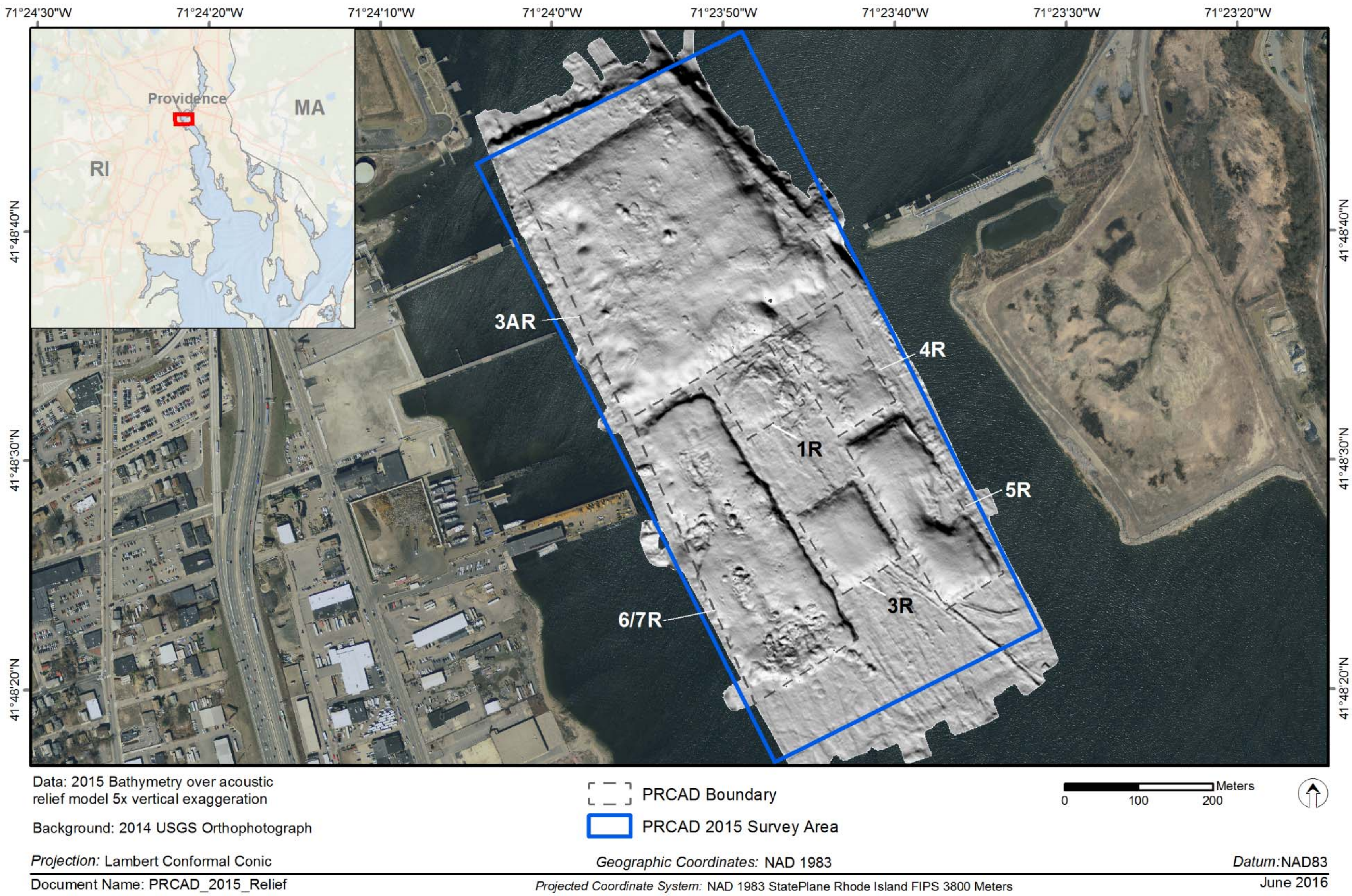

Figure 3-2. Acoustic relief map (hill-shaded grayscale) of PRCAD – October 2015

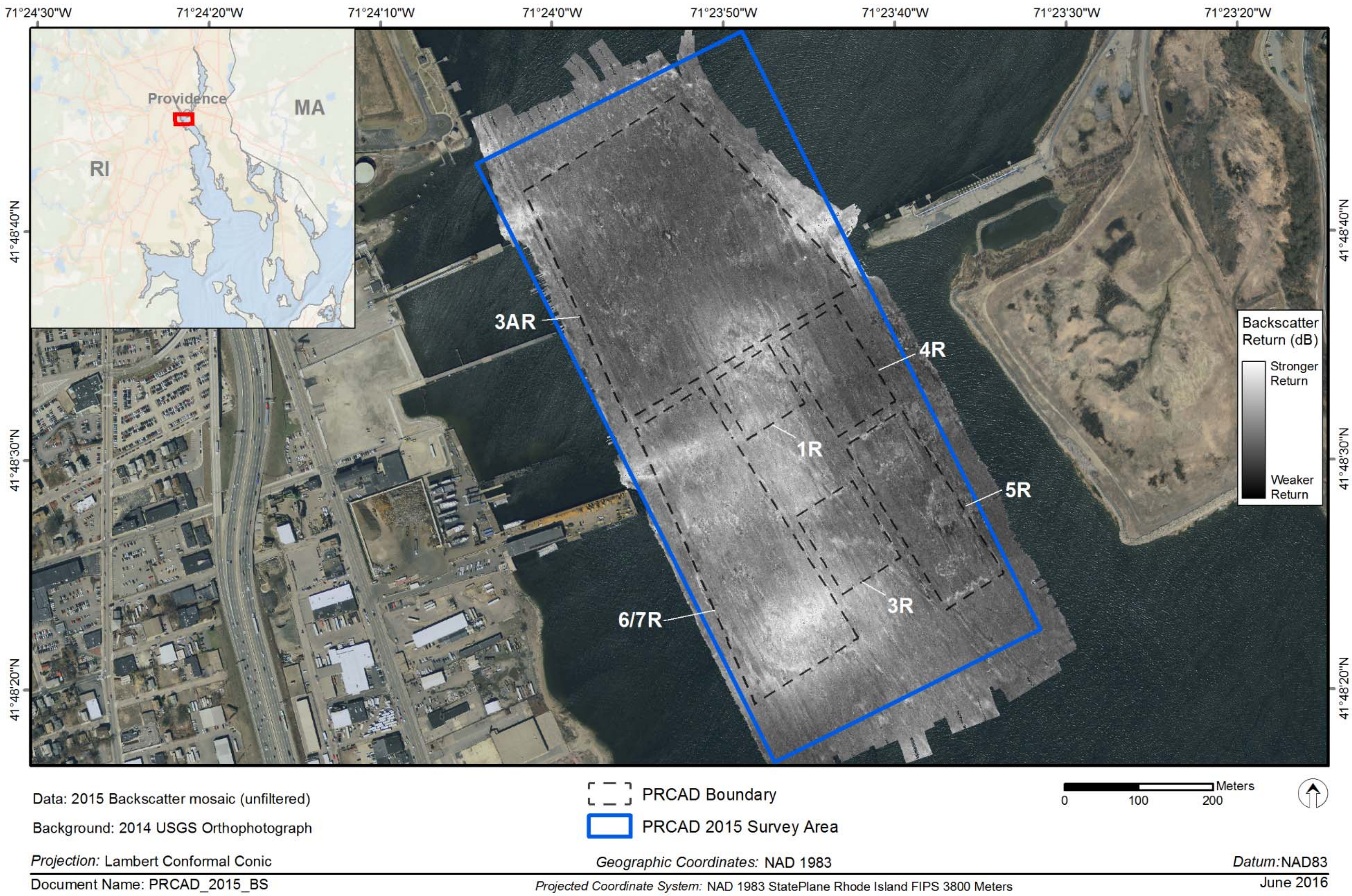

Figure 3-3. Mosaic of unfiltered backscatter data of PRCAD – October 2015

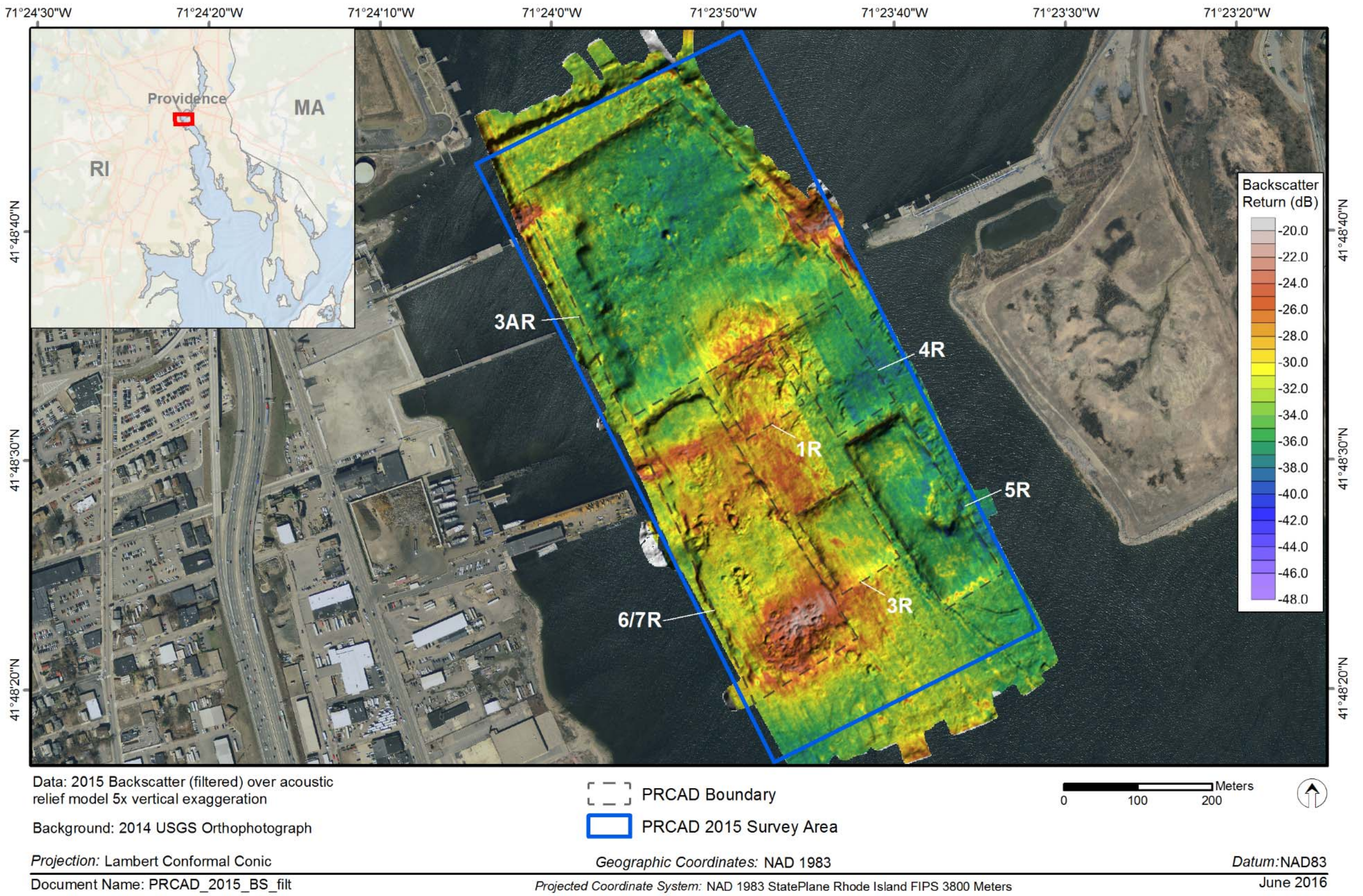

Figure 3-4. Filtered backscatter over acoustic relief model of PRCAD – October 2015

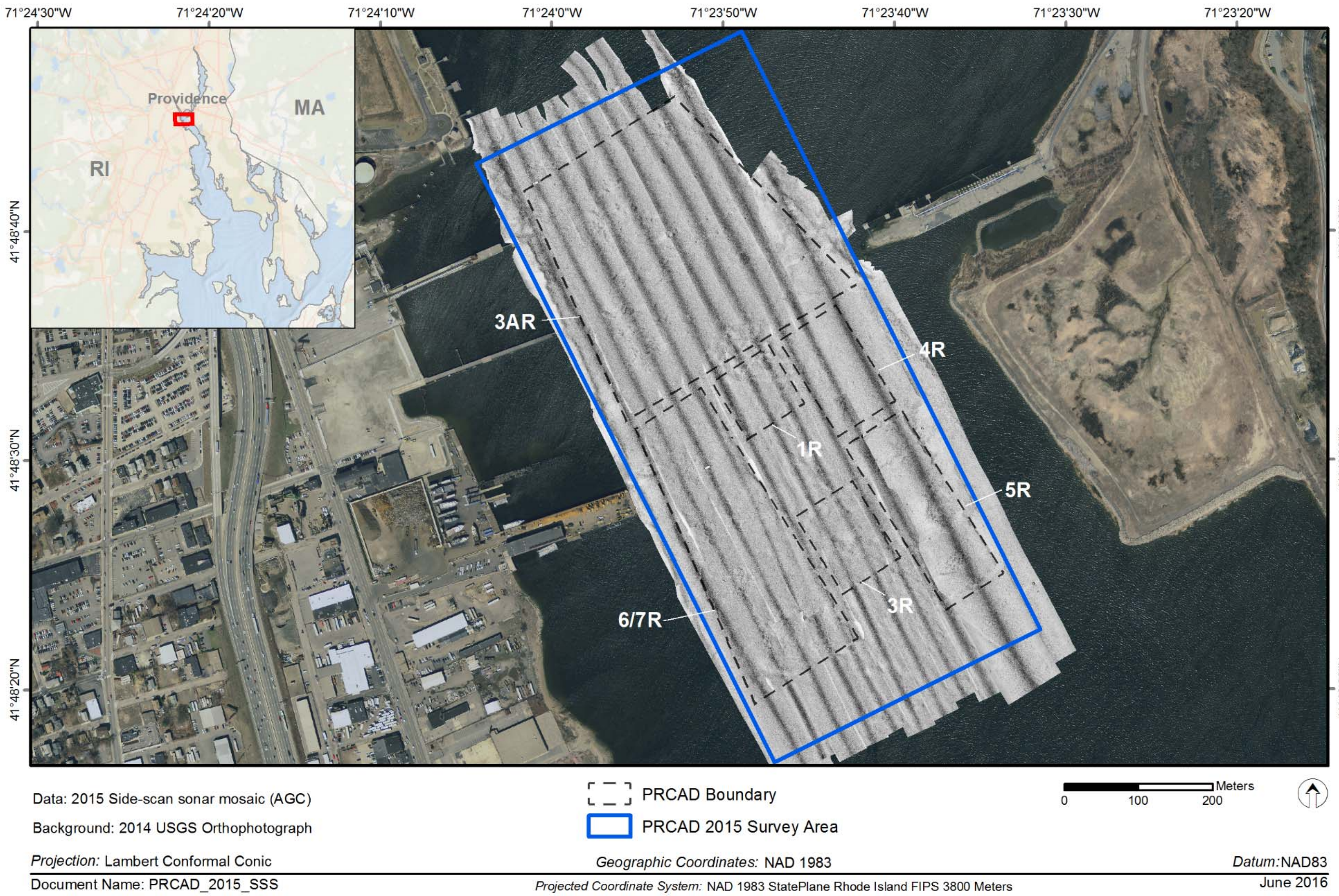

Figure 3-5. Side-scan mosaic of PRCAD – October 2015

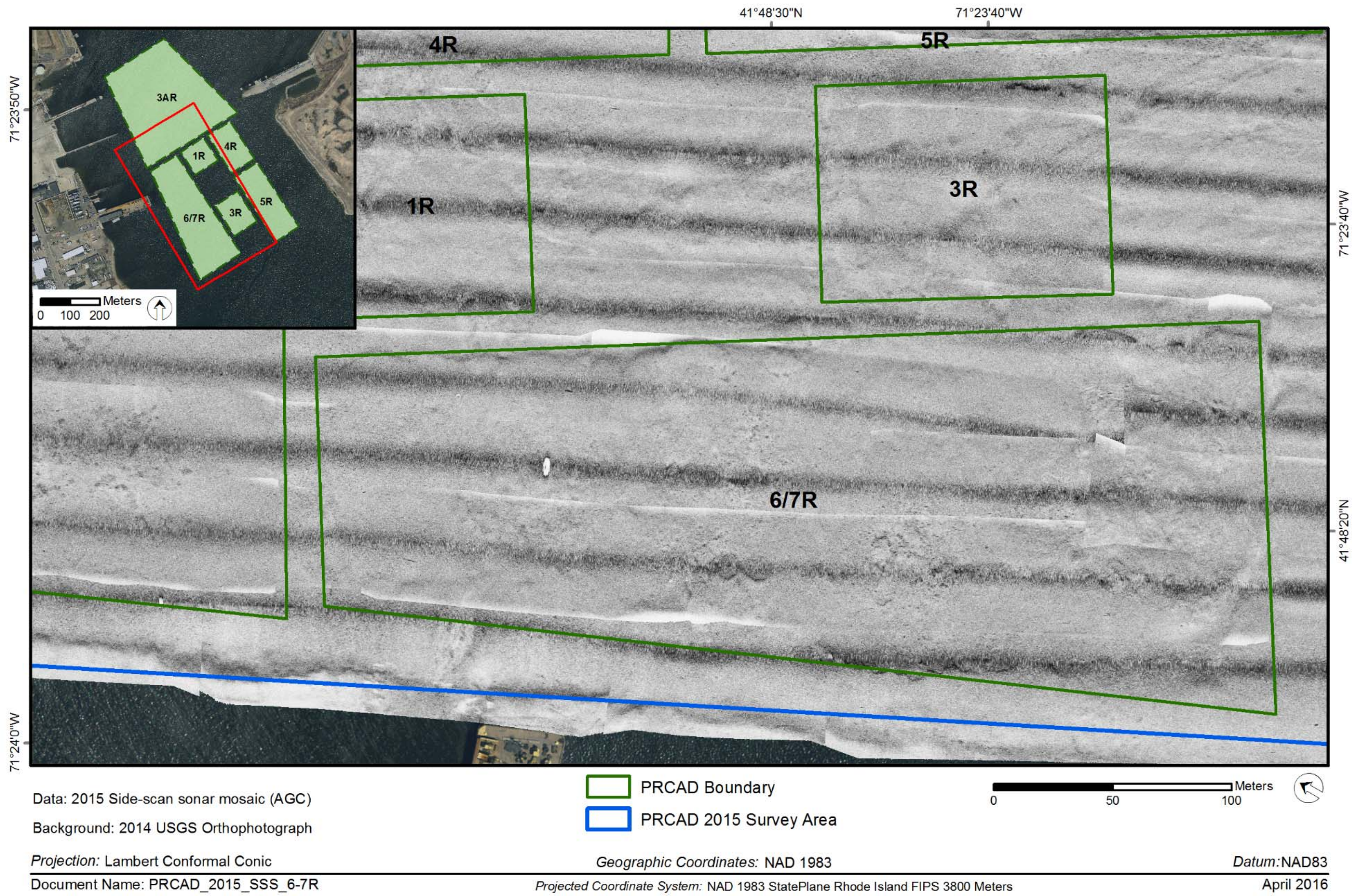

Figure 3-6. Side-scan mosaic close-up of Cell 6/7R of PRCAD – October 2015

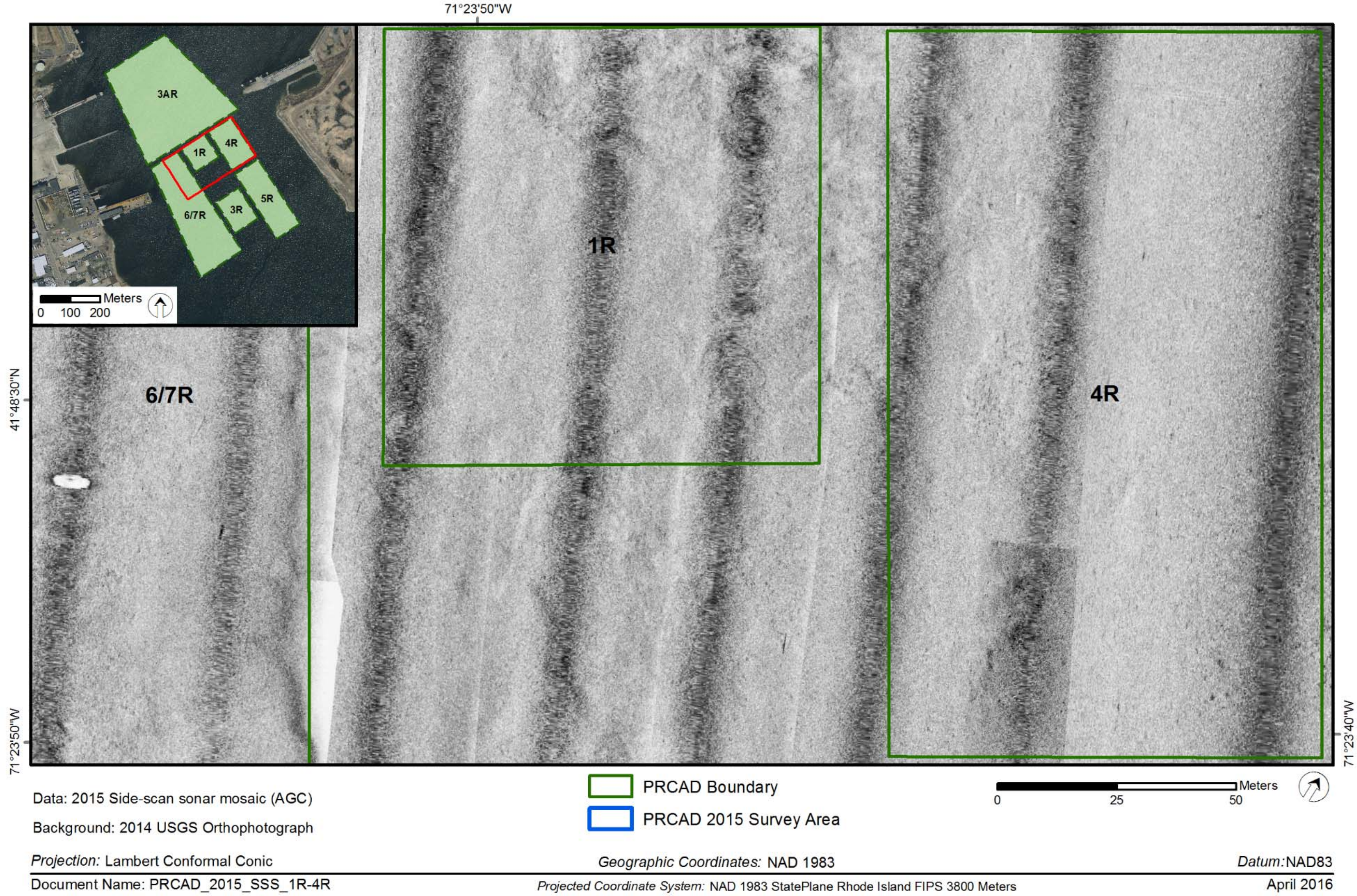

Figure 3-7. Side-scan mosaic close-up of Cells 1R and 4R of PRCAD – October 2015

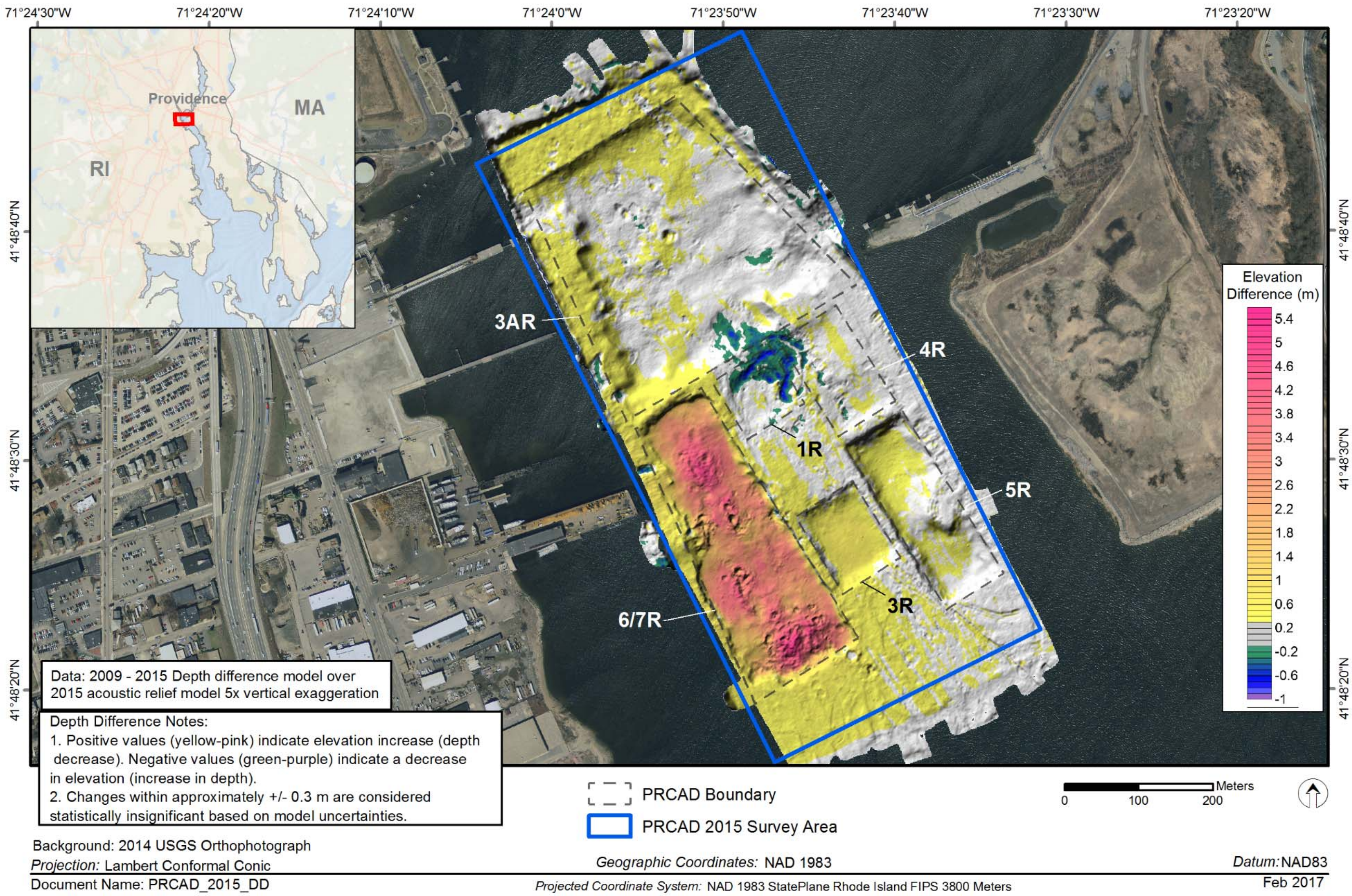

Figure 3-8. PRCAD depth difference: 2015 vs. 2009

4.0 SUMMARY

The 2015 multibeam acoustic survey provided a high resolution bathymetric assessment of the Providence River CAD cells, documenting the disposal of material targeted at CAD Cell 6/7R from various coves and marinas in Rhode Island. Targeted placement of disposal material achieved its goal. Dredged material was primarily limited to the southwestern portion of the survey area in CAD Cell 6/7R where most of the sediment accumulation was observed. Since 2009 as much as 5.5 m of material accumulated in portions of the CAD cell, with the majority of Cell 6/7R having 5 m of dredged material accumulation between 2009 and 2015. In a portion of the survey area, primarily around CAD Cells 1R and 4R, an erosion of less than 1 m of material occurred. The majority of the survey area showed no change or less than 1 m of accumulation. Thus targeted placement of material at CAD Cell 6/7R achieved its goal, with little to no displacement of material outside of the prescribed boundary.

5.0 REFERENCES

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6.0 DATA TRANSMITTAL

Data transmittal to support this data summary report will be provided as a separate deliverable for inclusion in a Technical Support Notebook. The data submittal will include:

- Scope of Work
- Raw and processed acoustic survey data
- Survey field logs
- Report figures and associated files, including an ArcGIS geo-database
- Electronic copies of all final report products

APPENDIX A

TABLE OF COMMON CONVERSIONS

Metric Unit Conversion to English Unit		English Unit Conversion to Metric Unit	
1 meter 1 m	3.2808 ft	1 foot 1 ft	0.3048 m
1 square meter 1 m^2	10.7639 ft^2	1 square foot 1 ft^2	0.0929 m^2
1 kilometer 1 km	0.6214 mi	1 mile 1 mi	1.6093 km
1 cubic meter 1 m^3	1.3080 yd^3	1 cubic yard 1 yd^3	0.7646 m^3
1 centimeter 1 cm	0.3937 in	1 inch 1 in	2.54 cm

APPENDIX B

PRCAD DISPOSAL LOG DATA FROM 2009 TO 2015

Project name	Disposal season	Load volume (m^3)	Load volume (yd^3)	Contractor	Placement cell
RIDEM - Fort Adams, Newport, RI	2014-2015	9,323	12,194	AGM Marine	6-7R
USCG/Haskell, Newport, RI	2014-2015	906	1,185	AGM Marine	6-7R
Brewer Cowesett Marina, Warwick, RI	2014-2015	4,879	6,382	OSM Marine	6-7R
Brewer Greenwich Bay Marina, Warwick, RI	2014-2015	4,795	6,271	OSM Marine	6-7R
Sims Metals, Providence, RI	2013-2014	6,996	9,150	AGM Marine	6-7R
Quonset Development Corporation, North Kingstown, RI	2013-2014	44,165	57,765	Great Lakes	6-7R
Ponaug Marina, Warwick, RI	2013-2014	2,926	3,827	OSM Marine	6-7R
Dickerson's Marina, Warwick, RI	2013-2014	18,243	23,861	OSM Marine	6-7R
Sims Metals, Providence, RI	2011-2012	22,216	29,057	AGM Marine	6-7R
Brewer Greenwich Bay Marina, Warwick, RI	2011-2012	5,217	6,823	OSM Marine	6-7R
Lavin's Marina, Barrington. RI	2010-2011	7,614	9,959	OSM Marine	6-7R
City of Newport, RI	2009-2010	5,617	7,347	Reagan Construction	6-7R
Namiotka Residence, North Kingstown, RI	2009-2010	370	484	Tripp Marine	6-7R
Brewer Wickford Cove Marina, North Kingstown, RI	2009-2010	2,294	3,000	Tripp Marine	6-7R
	TOTAL	**135,559**	**177,305**		