Quality Assurance Project Plan

for

Support for L2 Committee Priority Tool Development: Validation of Three CRAM Modules

Task 3: Validation of the Depressional Wetland CRAM Module

Funding Number: CD-99T05801-0

Project Leaders: Ross Clark and Kevin O’Connor

Institution:

Central Coast Wetlands Group

at

Moss Landing Marine Labs

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Cooperative Agreement Numbers: CD-99T05801-0

Prepared by: Kevin O’Connor, Ross Clark

Principal Investigators: Signature indicates commitment to follow the procedures in this Quality Assurance Project Plan (QAPP).

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Signature *Date*

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QAO, MLML *Signature* *Date*

Project Officers: Signature indicates that this QAPP meets the programmatic requirements.

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Distribution List

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Field Equipment List

CRAM:

- Digital camera
- Handheld GPS
- Plant taxonomic guide (Hickman, 1993)
- Data sheets
- Clipboard
- Site map / imaging

Water Chemistry, Macroinvertebrates and Algae:

- See pg. 12 of the SOP for Collection of Macroinvertebrates, Benthic Algae, and Associated Physical Habitat Data in California Depressional Wetlands (Appendix B)

1. Overall Goals and Objectives

The overall goal of the project is to validate the California Rapid Assessment Method (RAM[1]) for Depressional wetlands in California. The field testing of the module will focus on wetlands northern parts of the state as the data will be combined with data already collected in southern California and the San Francisco Bay Area for the overall validation effort. An organizational structure (the L2 Committee) is in place to foster collaboration and coordination among the CRAM development teams to ensure new CRAM modules are consistent with each other.

The Depressional wetland CRAM will assess depressions based on visible conditions that indicate functional levels of support for beneficial uses and ecological services. Field tests will be used to identify suites of visible conditions, termed "metrics", that indicate important wetland functions.

The development of CRAM for this class of wetland involves 2 basic analytical steps: (1) *semi-quantitative verification* of the metrics based on best professional judgment and a field tested evaluation of the metrics' suitability to describe wetland conditions in the study areas (this step was completed in 2013 under funding for the USFWS); and (2) *quantitative verification* using existing and new data sets to examine the relationship between the CRAM metrics and a range of ecological services from field intensive collection methods (this step will be completed in summer 2014).

The overall goal of CRAM is to provide a rapid, scientifically defensible, and repeatable assessment methodology that can be used routinely in wetland monitoring and assessment programs. A CRAM development goal is to create a tool that is applicable to wetlands of a specific type throughout the state of California. The general framework of CRAM (four main attributes of condition composed of 2 or more metrics) should be consistent across wetland types and statewide, yet allow for customization to address special characteristics of different regions and wetland classes.

CRAM is designed for routine use in local, regional, and statewide programs to monitor wetlands. It provides a consistent approach, without neglecting characteristic differences in wetland form or function between regions or between types of wetlands. CRAM is primarily intended for cost-effective, ambient monitoring and assessment at different scales, ranging from individual wetlands to watersheds, regions within the state, and to the state as a whole. The use of CRAM for ambient monitoring will, over time, help wetland managers and scientists quantify the relative influence of anthropogenic stress, management actions, and natural disturbance on the spatial and temporal variability in reference conditions. This information can then be used in the design, management, and assessment of wetland projects.

Additional, specific applications of CRAM could include: (1) preliminary assessments of wetland conditions and stressors to determine the need for intensive monitoring; (2) evaluation of wetland project performance under the Coastal Zone Management Act, Section 1600 of the California State Fish and Game Code, Sections 401 and 404 of the Clean Water Act, and local government wetland regulations; and (3) assessment of state-sponsored restoration or mitigation progress relative to ambient conditions, reference conditions, and expected ecological trajectories.

CRAM is not intended to replace any existing tools for, or approaches to, monitoring or assessment, and CRAM will be used at the discretion of governmental agencies and other organizations. For the

[1] Appendix A contains a list of all the acronyms used in this document.

assessment of compensatory mitigation projects and very large restoration projects, CRAM may augment standardized intensive monitoring procedures.

The overall objective of the project is:

CRAM Verification and Validation

1.1: Verification of Depressional CRAM is the process of refining CRAM metrics using BPJ to ensure that they do not exhibit strongly biased scores. Verification has occurred at a number of different systems representing a range of condition throughout the state. The module was developed from extensive visits by CCWG staff and Regional experts to a variety of systems representing a range of habitat condition. The module was based on a conceptual model of wetland form and function that informed metric development.

1.2: Validation of Depressional CRAM will test the ability of the CRAM module to distinguish among systems of differing condition that are affected by minimal, moderate, and severe levels of anthropogenic stress and thus provide various levels of ecological services. Existing and newly collected Level III data will be used to validate whether the new module is sensitive to varying levels of habitat condition.

2. Organizational Structure

This interdisciplinary project will be conducted by the Principal Investigators (PIs) from the Central Coast Wetlands Group (CCWG) at Moss Landing Marine Laboratories (MLML). The Central Coast Wetlands Group (CCWG) is an affiliate research group at Moss Landing Marine Laboratories focused on the study, preservation and restoration of Central Coast Wetlands. PIs will be advised by the team of state representatives and academic scientists experienced with CRAM who make up the Level 2 Committee of the California Wetland Monitoring Workgroup.

2.1. Organizational Structure

Title/Key Tasks	Name	Affiliation	Contact Information
EPA Project Officer/Oversees Direction of Project	Melissa Scianni	USEPA Region 9	Tel: (415) 972-3821 scianni.melissa@epa.gov
Project Primary Investigator/Directs overall Project	Ross Clark	CCWG @ MLML	Tel: (831) 771-4411 Fax: (831) 632-4403 rclark@mlml.calstate.edu
Project Manager/Directs Day-to-Day Work of Project	Kevin O'Connor	CCWG @ MLML	Tel: (831) 771-4495 Fax: (831) 632-4403 koconnor@mlml.calstate.edu
Project QA Manager/Oversees Day-to-Day QA Activities for Field, Lab, Data Review	Kevin O'Connor	CCWG @ MLML	Tel: (831) 771-4495 Fax: (831) 632-4403 koconnor@mlml.calstate.edu
Project QA Officer/Oversees QA overall QA for project	Stacy Kim	MLML	Tel: (831) 771-4429 Fax: (831) 632-4403 skim@mlml.calstate.edu
Staff/Performs Project Tasks	Cara Clark	CCWG @ MLML	Tel: (831) 771-4428 Fax: (831) 632-4403 cclark@mlml.calstate.edu
Staff/Performs Project Tasks	Sarah Stoner-Duncan	CCWG @ MLML	Tel: (831) 771-4485 Fax: (831) 632-4403 sstoner@mlml.calstate.edu
Contractor-Assists with development of conceptual model, L3 data collection	Sarah Pearce	SFEI	Tel: (510) 746-7354 sarahp@sfei.org

2.2. California Wetlands Monitoring Workgroup and L2 Committee membership

California Wetlands Monitoring Workgroup (CWMW)

Co-Chairs
Josh Collins (SFEI)
Melissa Scianni (USEPA Region 9)
Participating State Agencies
California Coastal Commission
California Department of Fish and Game
California Department of Parks and Recreation
California Department of Water Resources
California Resources Agency
California State Lands Commission
Central Coast Regional Water Quality Control Board
Central Valley Regional Water Quality Control Board
Los Angeles Regional Water Quality Control Board
San Diego Regional Water Quality Control Board
San Francisco Bay Regional Water Quality Control Board
Santa Ana Regional Water Quality Control Board
State Water Resources Control Board
Participating Federal Agencies
NOAA-National Marine Fisheries Service
Natural Resources Conservation Service
U.S. Army Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
Other Participating Organizations
Humboldt Bay Harbor District
Central Coast Wetlands Group @ Moss Landing Marine Laboratories
San Francisco Estuary Institute
Southern California Coastal Water Research Project
UC Merced

Level 2 Committee of the California Wetlands Monitoring Workgroup	
Name	Organization
Ayzik Solomesheh	Consultant
Cara Clark	Central Coast Wetlands Group @ Moss Landing Marine Labs
Chad Roberts	Consultant
Chris Solek	Southern California Coastal Water Research Project
Cliff Harvey (Chair)	State Water Resources Control Board
Cristina Grosso	San Francisco Estuary Institute
Dave Weixelman	U.S. Forest Service
Eric Stein	Southern California Coastal Water Research Project
Joshua Collins	San Francisco Estuary Institute
Kevin Lunde	Bay Area Regional Water Quality Control Board

Kevin O'Connor	Central Coast Wetlands Group @ Moss Landing Marine Labs
Lindsay Tunis	AECOM
Marie Denn	National Park Service
Paul Jones	USEPA Region 9
Rebecca Loffler	Caltrans
Ross Clark	Central Coast Wetlands Group @ Moss Landing Marine Labs
Sarah Pearce	San Francisco Estuary Institute

2.3. Responsibilities of Principal Investigators, Regional Partners, TAC, and L2 Committee

1. Principal Investigators will:
    a. Organize the research approach to meet the project goals and objectives.
    b. Develop plans for compiling, verifying, and transmitting field data
    c. Analyze data
    d. Prepare CRAM documents including outreach materials, instruction manuals, and interim and final reports for new CRAM module development.
    e. Present CRAM development and results at scientific conferences and write manuscripts for scientific publications.
2. Regional Partners and L2 Committee
    a. The L2 Committee will review and recommend revisions of the Depressional CRAM module for applications of importance to a given region.
    b. Regional partners will assist in regional data collection and compilation for validation of the CRAM. The primary individuals involved in data collection will be: Kevin O'Connor, Cara Clark, Sarah Stoner-Duncan, and Sarah Pearce
3. QA Officers -- QA Officers will ensure:
    a. that the QAPP and standard operating procedures (SOPs) are implemented as written,
    b. that technical audits are conducted when appropriate,
    c. that corrective actions are implemented,
    d. that data are reviewed for usability against the project's stated data quality objectives (DQOs), and
    e. that data are appropriately qualified when they do not meet project DQOs.
    f. QA Officers should be independent of data collection and analysis activities.

2.4. Permit Requirements

Permits will be required to access certain depressional wetlands depending on the landowner. If a site is held in private ownership we will work with the landowner to obtain access. If it is not granted we will drop that site and move on to the next potential site in our list. Permits and access permission to sites will be obtained prior to the beginning of the field season and data collection. Additionally we will obtain a scientific collection permit for CDFW for the collection of macroinvertebrates.

3. Conceptual Models

Central Coast Wetlands Group has tentatively adopted draft conceptual models for (1) wetland form, function of California's Bar-built Estuaries; and (2) the EPA 3-tiered approach to regional wetland monitoring.

3.1. Wetland Form and Function

The evolution and natural maintenance of a wetland depends on supplies of water and sediment, as mitigated by vegetation. Water is needed to submerge the land, and dynamics create appropriate hydric soils to enable wetland plants to survive. The quality and quantity of supplies of water and sediment are mainly controlled by climate, geology, and land use characteristics within the watershed. Vegetation affects hydrogeomorphic processes and the distribution and abundance of wildlife. The interactions among all these dynamic factors lend to a variety of forms that continue change over time; climate and land use are always changing, plant and animal species evolve, and the species composition of natural communities changes due to invasions and local extinctions.

3.2. The EPA Three-tiered Approach to Wetland Monitoring

US EPA is supporting a number of efforts in the nation to develop and strengthen wetland monitoring and compensatory mitigation through grant assistance under the Wetland Development Grants and policy and technical support from Headquarters and the Regions. The technical framework for EPA's support consists of three complementary levels: (1): Landscape Assessment; (2) Rapid Assessment; and (3) Intensive, Site-Specific Monitoring.

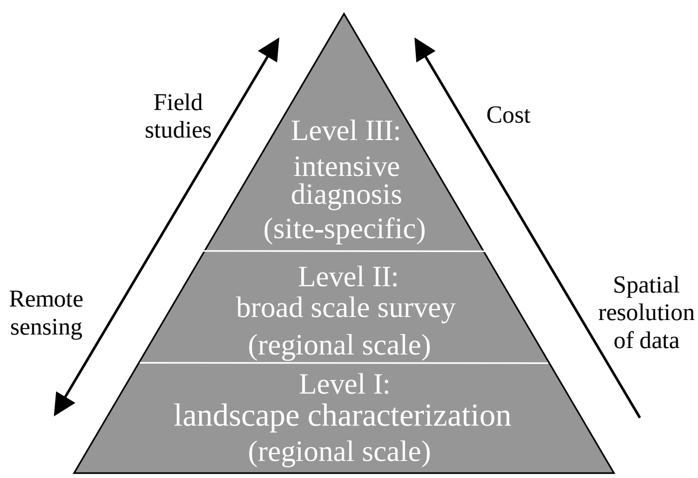

Figure 1. Conceptual model of the EPA 3-tiered approach to wetland monitoring.

The resolution of the monitoring data, its site-specificity, the amount of fieldwork required to generate the data, and its cost all increase from Level I to Level III. The monitoring results from each level address different needs for information, and each level of monitoring can be used to verify the other levels.

Landscape Assessment (Level I) relies almost entirely on Geographic Information Systems (GIS) and remote sensing data to obtain information about watershed conditions and the distribution and abundance of wetland types within watersheds. A Level-I assessment can generate a sample frame for Level II and

Level III assessments of wetlands sites.

The CRAM will be an example of Level II monitoring. After the CRAM is validated through Level III studies, it can be used to rapidly assess ambient conditions and the performance of wetland projects. Level II methods can also be used to develop hypotheses about the causes of the observed conditions and to validate Level-I assessments.

Intensive Site Assessment (Level III) provides the field data necessary to validate the Level-II (rapid assessment) methods, characterize reference condition, test hypotheses about the causes of wetland conditions as observed through Level II, and develop design and performance standards for wetland projects. Wetland bio-assessment criteria (i.e., use of indices of biological integrity or IBIs) can be developed and used in Level-III assessments. CRAM can also be adapted for use as a component of Level-III monitoring.

4. CRAM Validation Steps

4.1. Conceptual Approach to Module Development

CRAM module development includes several steps: 1) creation of a standard definition and conceptual model; 2) CRAM module development; 3) verification of draft module; and 4) validation of revised module (Figure 2).

Steps 1 through 3 have already been completed for this CRAM wetland module through prior funding.

The Validation Phase documents relationships between CRAM results and independent measures of condition (Level III data) to establish CRAM's ability to generate meaningful and repeatable measure of wetland condition. However, the analysis of CRAM relative to Level III data sources does not fit the traditional definition of validation. True validation of assessment models for natural systems is impossible because natural systems are never closed and because model results are always non-unique. Furthermore, available Level 3 data sets are themselves indices of wetland condition based on floral and faunal community composition. Assessment models (like CRAM) can only be evaluated in relative terms, and based on heuristic evidence from multiple independent measures of condition.

Once validated, a finalized module is produced by creating a final field book and training presentations. This finalized version of the module can be implemented through an ambient survey to produce a distribution of scores to which local and regional assessments can be compared.

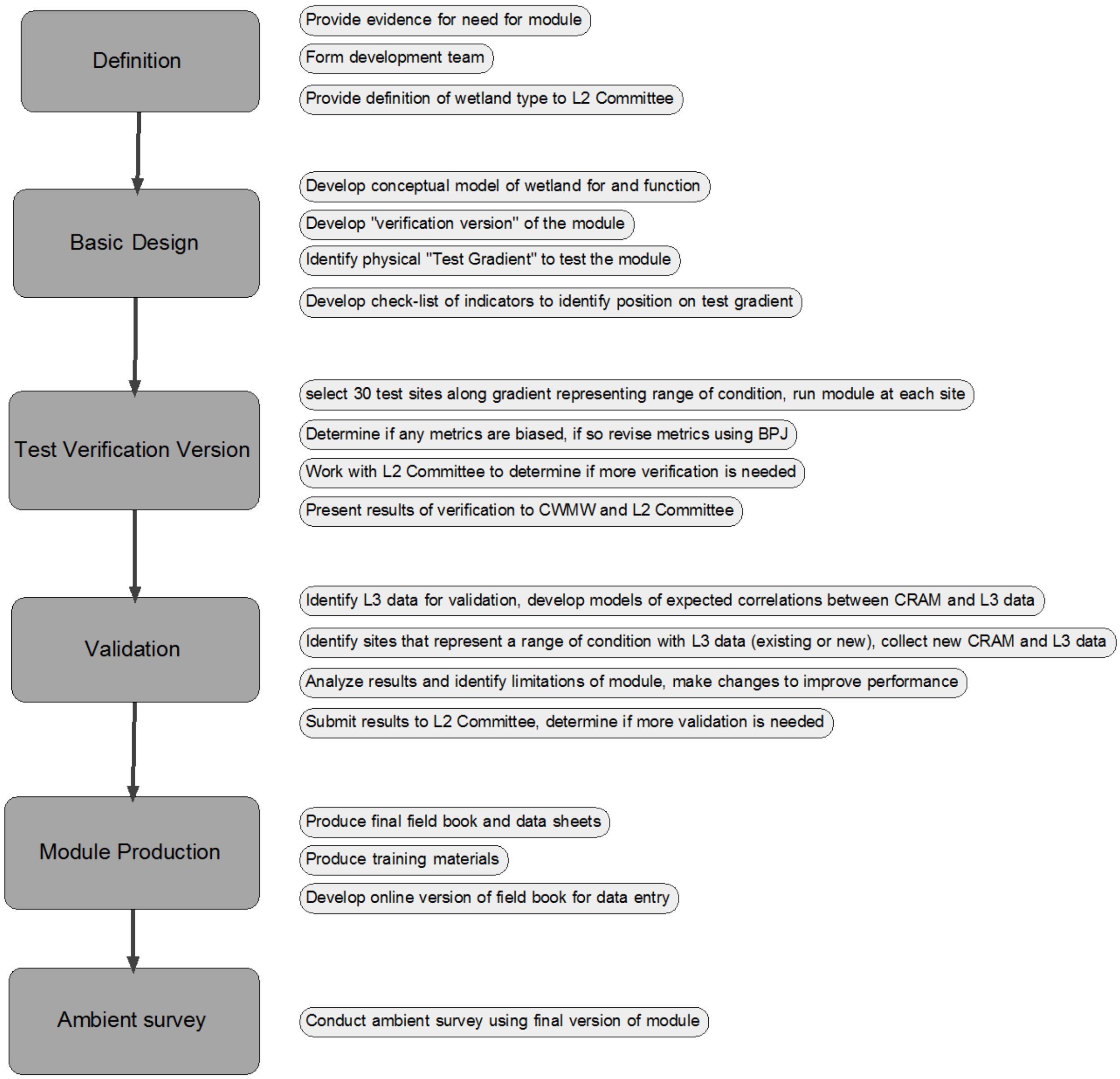

Figure 2+. Process for CRAM module development.

4.2. Validation Process

The thresholds for dividing the condition categories (A, B, C, D) of a continuous metric (e.g., patch richness, percent invasive plant species, buffer width, percent AA with buffer, and number of co-dominant plant species) will be modified based on the Level III data collected through the validation process. For example, the physical and biotic patch type data will be used to generate a distribution of values for patch richness abundance across study sites. Thresholds between adjacent condition categories for the Physical and Abiotic Patch Richness metrics will be determined based on the distributions of these data and their relationship to Level III data sets.

4.3.1. Validation Approach

The Depressional CRAM validation effort will investigate relationships between CRAM scores and Level III data using a "top down" approach, from the general (overall CRAM score) to the specific (CRAM attributes and then metrics). This hierarchical approach will first assess the performance of the overall CRAM score (a condition variable of interest by managers and regulators) and details of the subunits that comprise the overall score (attributes and metrics). The emphasis of validation will be to ensure that the various components of the CRAM scores relate to empirical data as predicted and as captured in the conceptual model. If CRAM and Level III data correlate as predicted (Table 1), little numerical adjustment of the metrics and attributes will be required. If these relationships are not as predicted, then metrics may be scaled, their thresholds adjusted or possibly redefined. Attributes that do not reflect condition as predicted from Level III data variables may be weighted or otherwise recomputed to obtain the desired relationships. These modifications will be documented as part of a validation report.

4.3.2. Validation of CRAM Index Score, Attributes, and Metrics

CRAM Index, attribute, and metric scores will be compared with Level III data that reflect levels of ecosystem services for various phyla and species. Level-III data have been identified for use in validation (detail in Section 4.3.3 of this document, and listed in Table 1). Direct measurement of wetland condition or function is not possible as there is no defined metric; therefore, CRAM validation focuses on indirect measures of condition, such as floral or faunal composition. We will evaluate attribute performance by comparing scores to Level III field data that reflect various indices of community structure and high-order function of the ecosystem. These data integrate wetland functions represented by various CRAM attributes in time and through space.

Graphical tools, such as scatter plots, will be used to characterize the relationship between empirical data and CRAM metric, attribute and index scores. Metric scores are expected to either bear no relationship to Level III data (in the case of metrics with no appropriate Level III data for comparison), or metric scores should relate monotonically to Level III data. In cases where no relationship is detected, CRAM metrics will be revised (e.g., changing the prose description of alternative categories of conditions for the metric, or collapsing or adding categories) to improve the relationship, especially if the same metric has unexpected relationships to more than one Level III data set, suggesting that there were problems with the original construction of the metric. CRAM index and attribute relationships with selected Level-III data have been predicted (Table 1). Interim results of validation analyses will be shared with the L2 Committee for their feedback during this process.

It is recognized that the attributes and the corresponding metrics constitute a comprehensive framework for an expert visual inspection of wetland condition, and as such, all the metrics and attributes are important parts of CRAM, even if they are in some ways functionally interrelated and therefore redundant. Redundancy of metrics does not justify their elimination, but does lead to potential modification to better elucidate additional information.

Table 1. Level III data variables for use to validate the Depressional CRAM module and Potential relationships between data variables and Depressional CRAM module index, attribute scores

Metric measured	Overall CRAM Score	Buffer/Land scape	Hydrology	Physical Structure	Biotic Structure
Physical Habitat	+			+	+
Water Chemistry	+	+			
Macroinvertebrate IBI	+	+		+	+
Benthic Algae IBI	+	+	+	+	+

4.3. Validation of Metrics, Attributes and Index Scores

4.3.1. Selection of Validation Sites

15 Validation sites will be selected that represent a range of conditions (i.e. disturbance gradients) from highly disturbed to relatively pristine sites. These 15 sites will be added to 60 other sites that have already been assessed in Southern California and the San Francisco bay Area. The minimum sample size of state-wide Level III data sets used for validation will be 45 sites, which will allow for statistical comparison among the four categories of condition for each score class (A, B, C, D).

Validation sites will be chosen that vary across a range of condition, and represent the entire study area. To do this, we will consult with regional experts that have had extensive experience in the systems we are studying. Additionally we will use Google Earth to select systems with varying levels of encroachment by urban and agricultural land uses and varying levels of development in their associated watershed. Property access will be assured prior to sampling. If access is not granted the site will be dropped and the next site in the resource list will be used. Our sampling procedures may be altered depending on restrictions from land owners/managers.

4.3.2. Obtaining CRAM Data from each Validation Site

CRAM metrics will be scored at each validation site by the CRAM Field Team, using the 2013 Depressional CRAM field book. The scoring process will include office, field evaluations of CRAM metrics, and completion of the CRAM stressor checklist. The following information will be collected at each validation site to aid in interpreting site condition, and facilitate future revisions to the Depressional CRAM module:

1. A site description, including on-site conditions (adjacent land uses, etc.)
2. Any biotic and/or physical patch types that do not appear on the lists currently included in the verification version of the module
3. Photographs and/or sketches of the site, including Assessment Area (AA) delineations
4. Documentation as to why the site was selected as a “high”, “intermediate”, or “low”-quality reference site, if applicable
5. Any existing collateral data and imaging for the site

The CRAM AA delineation will encompass geographic boundaries similar to those of the Level-III data collection, while still adhering to the rules for delineating the AA. A GPS unit and aerial imaging will be used to help locate the exact position of the Level-III work. All data points will be taken in the NAD83 projection.

The CRAM AA will be delimited based on breaks in hydrology (as per CRAM v 6.1). Large systems too extensive to be evaluated in a single assessment will be broken into smaller units and a single AA will be randomly chosen. Once the CRAM AA is delineated, the entire area will be walked and all physical and biological features will be noted. It is a requirement that the observer inspects the entire AA.

4.3.3. Collection of new data for validation

Collection of new Level III data is needed because existing data for systems throughout the state are not sufficient to address the validation of the new CRAM module. All Level III data will be collected in accordance with the SWAMP approved SOP for Collection of Macroinvertebrates, Benthic Algae, and Associated Physical Habitat Data in California Depressional Wetlands (SOP) (Fetcher et al. 2014). Please see Appendix B for the specifics of data collection.

4.3.3.1. Physical Habitat

Key aspects of depressional physical habitat will be evaluated methodologies laid out in the SOP. During the initial wetland pacing, data on physical characteristics of the wetland (that could serve as explanatory factors for the biotic community composition data) are collected at the level of the wetland as a whole, as well as at the nodes associated with each of the Macroinvertebrate and algae sampling nodes. Some of the wetland characteristics should be determined beforehand during an office assessment, and then confirmed in the field. These include the wetland's origin (natural or artificial), its age and function (if created), whether or not vector control activities currently occur at the wetland (and what kind), what the wetland's hydroperiod is believed to be, and wetland area. Other data to record include wetland length and width, observations relating to weather conditions during the assessment period, and percent cover of vegetation across the pond.

4.3.3.2. Water Chemistry

To evaluate water chemistry, parameters (DO, temperature, salinity, and conductivity) will be collected with a hand held YSI multi parameter probe (www.ysi.com). Water chemistry field measurements collected prior to any other sampling at each node. Turbidity and probe measurements are recorded at two nodes at roughly opposite ends of the wetland. Probes should be calibrated prior to starting fieldwork, as recommended by the SWAMP QAPrP, and the calibration date added to the field data sheet. Because of the influence of particulates, the order of measurements should be:

- Turbidity (NTU) (either on YSI or using portable meter)
- Water temperature (°C)
- Specific conductivity (µS/cm)
- Salinity (ppt)
- pH
- Dissolved oxygen (mg/L and % saturation)

4.3.3.3. Macroinvertebrates

Data collected include information about benthic macroinvertebrate (BMI) species diversity, abundance, and Index of Biotic Integrity. The results of bioassessment provide information about water quality and benthic habitat condition resulting from perturbations such as contamination and sedimentation from adjacent sources.

4.3.3.4. Benthic Algae

Data collected include information about benthic algae (diatoms) species diversity, abundance, and Index of Biotic Integrity. The results of bioassessment provide information about water quality and benthic habitat condition resulting from perturbations such as contamination and sedimentation from adjacent sources.

4.3.3.4. Photo Documentation

Photos will be taken to at each depressional wetland to record its overall condition at the time of assessment. Standard photos will be taken at the center of each CRAM Assessment Area in each of the four cardinal directions. The location information for each photo will be recorded on the basic information page of the CRAM data sheet. When the photos are downloaded to a computer their file names will be changed to include the data, site and bearing of the photo and placed in a folder with the site name and assessment date.

Additionally, photos capturing unique characteristics of each depressional system will be taken. These photos will be used to build a photo dictionary with examples of various levels and indicators of condition in these systems. They will be stored in the above-mentioned folders.

4.3.4. Validation Timeline

The schedule for the validation of the Depressional CRAM module is as follows:

1. Sites for CRAM validation data collection were selected in April of 2014. The criteria for selecting sites are outlined above.

2. Data collection will take place in June and July, 2014.

3. Analyses of CRAM and Level III will occur in Fall, 2014 as data collection ends.

5. Quality Assurance Methods

Quality Assurance/Quality Control procedures will be employed to assure that the CRAM field teams are obtaining information accurately when they are conducting CRAM assessments and collecting independent Level III data. As new data will be collected during validation of the CRAM, this QAPP addresses the required precision, accuracy, and completeness of the Level III validation data.

The objective of data management will be to assure that field and GIS data are accurately collected and verified for analysis and interpretation by CCWG/MLML. We will use procedures described herein to assure accuracy and consistency of data collection and processing.

Data sources that will be used for validating CRAM are summarized in the body of this document, and in greater detail in the attached protocols (see Appendices). Where they exist, we have also included approved QAPPs to accompany these protocols. Quality assurance measures are stipulated below for data sets that have not already undergone QAPP development and approval.

The following is a description of the basic QAPP procedures that will be followed during the validation effort. The field teams will be responsible for making sure that all data forms that are used in validation are filled out completely. Field Teams will provide the PIs with completed forms for a site within three days after the site is visited. The PIs will check each form for completeness (i.e., all fields requiring information are completed). If a PI finds that data are missing or that data have been incorrectly entered onto a form, then the persons who collected the information will be notified of the specific problem within two days after the form is submitted to the PIs, and, if necessary, sites will be visited again to obtain or correct the data in question.

5.1. CRAM Score Variation within Field Teams

This section outlines sampling procedures and support materials to be used while conducting the CRAM field assessments. While the focus of the validation effort will be for Depressional wetlands, these procedures apply to field assessments conducted at any of the seven CRAM wetland classes.

5.1.1. CRAM Training

A first step in the validation effort will be to convene key individuals assisting in the data collection effort to assure that all are interpreting the 2013 version of the Depressional CRAM module in a consistent manner. A field session will be hosted to review the validation goals and objectives, AA delineation, data sheets, and safety. Additional protocols for review include: buffers (what qualifies and what does not), metric ratings, field indicators, and biotic and physical patch types. Teams will conduct independent assessments and compare results and discuss differences.

5.1.2. Field Replications and Standardization

Procedures described below will ensure that CRAM scores collected in the field meet established criteria for precision. It should be noted that, unlike a laboratory analytical method where the result can be compared to a standard of known concentration, there is no "gold standard" for which CRAM can unequivocally be compared. Rather, the validation process assures CRAM results report condition in similar ways to Level III data sets. Therefore, accuracy is not a meaningful parameter against which to judge CRAM assessments, and as such is not included in the DQOs.

Each procedure will be completed as described in order to decrease sampling error and to define any remaining error. Precision objectives are described in Table 2. If a field team does not meet these objectives, corrective actions will be taken. Such corrective actions can include additional training in conducting CRAM AA delineation, interpretation of metric ratings, identification of field features assessed in CRAM, modifications to field book guidance and definitions.

Data compiled for all sites will be screened by the PIs. If errors and/or omissions are found CCWG/MLML will work with the data collectors to determine if the data were incorrectly entered into the database tables or if the data were not correctly obtained in the field. If errors in field measurements are identified, the PIs will omit these data and when possible, return to the sites and re-collect the information in question.

The project QAO will retain a copy of the QAPP, and will establish the quality assurance and quality control procedures found in this QAPP as part of the sampling, field analysis, and in-house analysis procedures. The QAOs will also review and assess all procedures during the life of the validation study against QAPP requirements, and will report all findings to the project PI(s), including all requests for corrective action. The QAO may stop any and all actions if there are significant deviations from required practices or if there is evidence of a systematic failure.

The field Team manager will be responsible for the day-to-day oversight of the project, and will insure that the data are passed, in a timely manner, to the appropriate persons for review. The QAO will review data regularly.

If an audit discovers any discrepancy, the QAO will discuss the observed discrepancy with the appropriate person responsible for the activity. The discussion will begin with whether the information was collected appropriately, what were the cause(s) leading to the deviation, how the deviation might impact data quality, and what corrective actions might be considered. The QAO has the power to halt all sampling if the deviation(s) noted are considered detrimental to data quality.

Table 2. CRAM Metric Data Quality Objectives.

Team Comparison	Precision	Completeness
Within each regional Field Team	+/- 8%	90%

5.1.3. Within Each Regional Team

The CRAM field team will include one or two individuals that consistently participate in running CRAM throughout the verification and validation phases. These field team leaders will provide consistent interpretation of the CRAM language.

5.1.4. CRAM Support Materials

All measurements of the CRAM field team will read and understand CRAM (as well as all other protocols for collection of new, independent data). Field guides and photo reference materials will be provided to all CRAM field members to help them develop an understanding of the complete range of conditions for each metric.

The Depressional CRAM Field book (Appendix D) includes numerous reference tables and figures to help the practitioner better interpret metric categories.

5.2. Quality Assurance Requirements for new Level III data being collected

The following additional measures address the specific needs of the independent data sets that will be collected.

5.2.1. Water Chemistry

Water chemistry measurements made in the field (Table 3) will be measured with a YSI 556 handheld data logger. To ensure precision, the first field measurement of each sample run will be duplicated three times. The YSI 556 MPS will be calibrated before entering the field according to directions provided by the manufacturer. All field equipment will be cleaned with tap or distilled water prior to use between sites either in the field or at Moss Landing Marine Laboratories. If problems occur during sampling and/or analyses they will be discussed with the project manager, director, or QA officer; appropriate, actions will be taken to remedy the problems prior to the next sampling effort. All data will be recorded on a standardized data form.

Table 3. Data quality objectives for field measurements.

Parameter	*Accuracy*	*Precision*	*Recovery*	*Completeness*
Dissolved Oxygen	± 0.5 mg/L	± 0.5 or 10%	NA	90%
Temperature	± 0.5 °C	± 0.5 or 5%	NA	90%
Conductivity	± 5%	± 5%	NA	90%
Salinity	± 0.1ppt	± 0.5 or 5%	NA	90%

5.2.2. Physical Habitat, Macroinvertebrates and Benthic Algae

We will follow the procedures laid out in the SOP for Collection of Macroinvertebrates, Benthic Algae, and Associated Physical Habitat Data in California Depressional Wetlands (Appendix B) as well as the QA/QC measures described in the State of California's SWAMP Quality Assurance Program Plan (Appendix C).

5.3. GIS Data sources

AA and buffer boundaries will be hand-drawn on aerial imaging at the time of site visits. Additional GIS data will include two sources of maps to describe the locations, extent, and characteristics of wetlands: The National Wetlands Inventory (NWI) of wetlands, and NAIP imagery of the USDA.

The NWI data (http://www.nwi.fws.gov) are available for California for this wetland type. The NWI uses manual photo-interpretation of aerial imaging supplemented with Soil Survey information and field checking to hierarchically place wetlands into systems, subsystems, and classes. The minimum mapping unit is usually between 1-3 acres. Additional information on data quality (attribute accuracy, logical consistency, and completeness); on data capture processes; and on the Cowardin classification is given by the NWI metadata (http://www.fws.gov/wetlands/Data/Metadata.html). These maps vary among the regions of the project, however, in terms of their accuracy, completeness, and vintage.

The NAIP imagery is a standard product of the USDA. The related metadata and production protocols are available through the California Spatial Imagery Library (CaSIL).

5.4. Site Selection

Selection of sites for CRAM validation will represent a range of condition (based on BPJ). The site-selection procedure is described in Section 4.3.1 of this document and are reported in Appendix F. Sites selected will be presented as GIS shape files for each region.

6. Data Management

Data management for this project will involve numerous types of information, including hardcopy and electronic imaging and other background information for sites selected for validation of the CRAM, completed field data sheets, and new data used in the validation effort.

CCWG/MLML will be responsible for managing the data for the entire project. Routine backups of the computing systems and databases are performed regularly. All records and data collected (including photos, water quality, CRAM assessments, etc.) will be stored permanently in the CCWG offices at MLML.

The following protocols will be followed for data management:

- Data will be delivered to the EPA project manager at the end of the project.
- The primary data storage shall be on a central university server.
- Periodically, all electronic data shall be backed up on an external hard drive (at least once per month). The backup hard drive shall be stored at an off-site location for at least 3 years.
- The data file names shall contain the last date on which they were significantly modified.
- Previous versions (with earlier dates) shall be maintained on the server as intermediate backups until they are backed up to a hard drive (see above).
- All initial data from field forms shall be entered into the appropriate database on the day following field sample collection, or as soon as is reasonably possible.
- After laboratory analysis is complete, all results should be entered into the database record for that particular field monitoring campaign as soon as is reasonably possible.
- All data sheets will be stored at Moss Landing Marine Laboratory for at least 3 years.
- Primary water quality data shall be maintained at Moss Landing Marine Laboratories.

6.1. Review, Verification and Validation of Information

Field crews will complete the field data sheets for CRAM validation, on hardcopy forms (Appendix E). Before leaving a site, field crews will check the data sheets for completeness. If, for some reason, the field data sheets are lost prior to entry in the database, or the electronic database is lost through computer failure, etc., the site will need to be revisited so that the data may be collected again.

As previously stated (under Section 5), the PIs will be responsible for making sure that all data forms that are used in validation are filled out completely. Field Teams will provide the PIs with completed forms for a site within three days after the site is visited. The PIs will check each form for completeness (i.e., all fields requiring information are completed). If a PI finds that data are missing or that data have been incorrectly entered onto a form, then the persons who collected the information will be notified of the specific problem within two days after the form is submitted to the PIs, and, if necessary, sites will be visited again to obtain or correct the data in question.

6.2. Uploading Field Data into the Database

Results will be uploaded into the Depressional CRAM validation database by the following method:

- Hardcopy field data sheets will be transferred to the PIs and checked for completeness and correctness. Information from the data sheets will be entered into the CRAM validation Excel database by data management staff at CCWG/MLML. The electronic forms will be compared to the original hardcopy data sheets and any errors in the database will be corrected. The original data field sheets will be retained by CCWG/MLML.

The data are uploaded only after they have been checked by the CRAM data collectors in the field, and, for completeness, by a PI.

Upon completion of the validation process, CRAM results will be integrated into the EcoAtlas/eCRAM (www.ecoatlas.org) through a eCRAM module that has been developed by partner institutions.

6.3. Validation Process

Data analysis will begin with exploratory exercises, such as generating descriptive statistics and histograms for each of the CRAM metrics, in order to understand the distribution of scores. This is important to confirm that the sample of sites truly reflected a meaningful distribution of condition. The Level-III data of each type will be plotted against CRAM scores, and individually for each attribute and metric. This will allow investigators to confirm assumptions about the relative nature of successive metric rating narratives in the new CRAM module and test the responsiveness of the method to discerning good vs. poor sites. Either a monotonic relationship, or no relationship at all, is expected between the CRAM metrics scores and Level-III data.

6.4. Report

CCWG/MLML will prepare a final Report that documents how the results of the field tests conducted during the validation effort were used to finalize the CRAM metrics and attributes scoring systems. This report will include, as a chapter, the QA/QC activities undertaken for the calibration. This chapter will evaluate the quality of the data based on the QAPP for CRAM validation. Project reports and peer-reviewed publications will include, as deemed appropriate, analyses of the validation data, as described in this version of the QAPP. The Report will discuss the sources of all data used, metadata for those data when available, how the data were assembled and manipulated in our analyses, estimates of data quality, statistical methods used in the validation analyses, and statistical significance and uncertainties in relationships between CRAM scores and independent data.

6.5. Corrective Actions

Data compiled for all sites will be screened by the PIs. If errors and/or omissions are found CCWG/MLML will work with their respective data collectors to determine if the data were incorrectly entered into the database tables or if the data were not correctly obtained in the field. If errors in field measurements are identified, the PIs will, when possible, return to the sites and re-collect the information in question.

References

Fetscher, A.E., Lunde, K., Stein, E.D., Brown, J.S. 2014. Standard Operating Procedures for Collection of Macroinvertebrates, Benthic Algae, and Associated Physical Habitat Data in California Depressional Wetlands.

Baldwin, B.G., Goldman, D.H., Keil, D.J., eds. 2012. The Jepson Manual: Vascular Plants of California. University of California Press, Berkeley.

Appendix A: List of Acronyms

AA	Assessment Area
ABL	Aquatic Bioassessment Laboratory
ANOVA	Analysis of Variance
CCWG/MLML	Central Coast Wetlands Group at Moss Landing Marine Labs
CRAM	California Rapid Assessment Method for wetlands
DQO	Data-Quality Objective
EMAP	Environmental Monitoring and Assessment Program
EPA	Environmental Protection Agency
GIS	Geographic Information System
IBI	Index of Biotic Integrity
NWI	National Wetlands Inventory
PI	Principal Investigator
QAO	Quality Assurance Officer
RAM	Rapid Assessment Method
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
SFEI	San Francisco Estuary Institute

Appendix B: SOP for Depressional Wetlands

Appendix C: SWAMP QAPP

Appendix D: Depressional CRAM field book

Appendix E: Field datasheets

Appendix F: Depressional wetland site list