Central Arizona Project

CAWCD Guidelines for Crossings

June 2016

Table of Contents

Acronyms and Abbreviations

AASHTO	American Association of State Highway and Transportation Official
AOE	Authorized Operating Entity
AWWA	American Water Works Association
CAP	Central Arizona Project
CAWCD	Central Arizona Water Conservation District
CFR	Code of Federal Regulations
CPS	Cathodic Protection System
CSV	Comma Separated Values
DOT	Department of Transportation
HDD	Horizontal Directional Drilling
kV	Kilovolt(s)
MERL	Materials Engineering and Research Laboratory
O & M	Operations and Maintenance
BOR	Bureau of Reclamation, also known as, Reclamation
ROW	Right-of-Way
WB-67	67-foot Wheelbase

BACKGROUND

The Central Arizona Project (CAP), owned and constructed by the United States Bureau of Reclamation, is a 336-mile long system of aqueducts, tunnels, pumping plants, and pipelines that carry water across Arizona. Designed to bring 1.5 million acre-feet of Colorado River water per year to Pima, Pinal and Maricopa Counties. CAP is the largest single renewable water resource in the state.

In 1971, the Central Arizona Water Conservation District (CAWCD) was created to not only provide a means for Arizona to repay the federal government for the reimbursable costs of construction, but to also assume the responsibility for the care, operation, maintenance and management of the system.

CAWCD's Land Department is responsible for managing all lands associated with the CAP. Water delivery is CAWCD's primary mission; therefore all proposed uses of CAP land (utility crossings, roadways, communication sites, etc.) are evaluated to determine the overall effect on the CAP.

1.0 PURPOSE

These guidelines are intended to assist agencies and developers in preparing project concepts and designs that do not adversely impact the CAP canal, dikes and dike detention and drainage basins, and are consistent with current land use and land use plans. Projects shall be submitted for approval early in the planning process. An exchange of information shall continue through final designs.

2.0 GENERAL LAND USE AUTHORIZATION INFORMATION

Requests for land use, either from the public or private sector requires that an application be submitted for review before CAWCD can grant a license permitting access and/or use of CAP property. Since the CAP is a federal project, any land decisions made by CAWCD shall abide by specific directives that are mandated by the United States Bureau of Reclamation.

All applicants shall contact CAWCD to see if a preliminary meeting is required. There is no cost associated with this initial meeting. At this meeting, it will be determined if the proposed use is a viable use of CAP property.

Contact the CAWCD Lands Department at 623 869-2555 or by e-mail at 2555@cap-az.com if you have any questions or want to schedule an appointment to discuss a proposed project.

3.0 GENERAL

CAP's technical review of the crossing, evaluates impacts on any existing CAP facility and does not determine the adequacy of the crossing design for the applicant's intended purpose.

The use authorization or consent document specifies criteria which, if followed, would not be deemed unreasonable interference. These review guidelines are strictly limited to those criteria which:

1. Protect CAP's facility and/or appurtenant facility from damage
2. Ensure unrestricted flow and quality of water in CAP's facility
3. CAP's ongoing O&M activities shall not be disrupted and construction activities shall be coordinated with CAP before starting. One of the O&M roads shall be kept available for CAP use at all times.
4. Prevent any burden of liability

These guidelines are provided as recommendations that apply to most CAP facilities. Each engineering design and consulting firm shall apply these guidelines using sound engineering judgment that best applies to their facilities and existing conditions. These guidelines are minimums, and local conditions may be more stringent depending on the direct impacts to facilities and lands.

Applications shall include a project description, calculations, specifications, and detailed construction plans showing plan views, profiles and sections, and grading plans of proposed work within or adjacent to CAP's property.

All CAP facilities shall be shown and labeled (e.g., "Centerline of xx-inch CAP Pipeline," "CAP Communication and Control Cable," etc.) The type and weight of the construction equipment crossing CAP pipelines, roads, and bridges as well as the crossing locations shall be included. Additional information, as identified in following individual specific feature sections of these guidelines, shall also be included with the application for review.

The following individual items shall be addressed by the applicant and evaluated by CAP as they may affect the CAP facility's engineering and O&M aspects. If unusual conditions are proposed for the encroaching structure or unusual field conditions within CAP property are encountered, CAP reserves the right to impose more stringent criteria than prescribed in these guidelines.

1. Structures shall not be constructed on CAP pipelines (whether fee owned or easement) including foundations, buildings, garages, carports, trailers, street light standards, supports for large signs, walls, longitudinal fences (except security/safety fences), power or telephone poles, and similar surface structures.

   The applicant may have to develop a contingency plan for any possible damage to a CAP facility. The contingency plan shall include:

   a. Means to repair the canal and a schedule to complete repairs
   b. Minimum flows expected after event

c. Review of geotechnical conditions surrounding the construction site

d. Assessment of how the proposed mitigations will address geotechnical conditions

e. Methods for restoring canal foundation material

f. A list of material, equipment, and personnel with qualifications to be used during mitigation work

g. A seal from a Professional Engineer on all relevant plans and drawings

2. Prior to construction, a joint inspection shall be conducted and the condition of existing facilities documented. CAP's property shall be restored to pre-existing conditions following completion of work.
3. When applications are requesting public use of trails and maintenance roads adjacent to or crossing the CAP canal, these facilities shall be fenced for safety to separate them from open canal water, except when CAP's property is used as a greenbelt and the applicant accepts legal hazard responsibility. Trails and maintenance roads shall be fenced on an as-needed basis whenever such fencing is warranted for public safety, restricted access, security, etc. If a fence is allowed within CAP's property, CAP shall approve the fence materials. Any gates allowed within CAP's property shall be at least 16 feet wide. CAP shall be provided with full access through any fences or gates.
4. Prior to construction of any structure that encroaches within CAP property; a "pothole excavation" shall be made to determine the locations of any existing CAP and non-CAP facilities and their appurtenant features that may be affected. All work within 24 inches of the underground utilities shall be done using hand-held tools only. The presence of a CAP inspector may be required throughout the excavation process, but this presence in no way relieves the applicant or their contractor of responsibility.
5. If CAP facilities need to be modified to avoid adverse impacts from the applicant's crossing facility, the applicant shall be responsible for the cost of such modifications. A construction schedule outlining the anticipated duration of the construction shall be submitted.
6. For crossings of all CAP facilities, CAP personnel familiar with the facilities (including cathodic protection systems) will obtain and provide copies of existing files showing information about existing buried facilities (center of pipeline, depth of cover, size of pipe, class of pipe, etc.) to the applicant, if requested.
7. Existing CAP facilities (e.g., canal lining, canal check structure, turnout structure, etc.) and appurtenances (e.g., existing blow-offs, air valves, vents, manholes, and/or cathodic protection test stations) and existing non- CAP facilities on CAP's property (e.g., petroleum pipelines, natural gas pipelines, communications lines, power lines, water lines, sewer lines, storm drain lines, etc.) shall be protected in place prior to and during construction.

8. The applicant and/or their contractor may be liable for all damages to CAP facilities and appurtenances as a result of construction and for any other damages or losses suffered by CAP or its water contractors, including power, irrigation, municipal and industrial water supply, and communication losses.
9. The points where the proposed utilities enter and exit CAP's property shall be plainly and permanently marked by sign posts extending 5 feet above grade. Applicants shall provide sign posts directly above their utilities at the security fence and at four wire barbed fences. The distance between adjacent sign posts shall not exceed 500 feet or as otherwise approved by CAP. Sign posts shall contain the name of owner/operator, contents of the pipeline, utility identification, and emergency contact telephone number. Sign posts for angle points that lie within roads or canals shall be offset and have a reference noted. The locations of the sign posts shall be shown on the plans.
10. Dig Permits – A dig permit shall be required for any digging on CAP property. The dig permit shall be completed by the construction company performing the work and approved by a number of departments within CAWCD. There is no cost to the applicant or their contractor for a dig permit.

11. Dive Permit – Any construction connecting to or over the CAP canal shall require a preliminary and post underwater inspection of the CAP canal liner. The preliminary dive is to inspect and document any cracks, holes or damage in the liner where the construction is scheduled to be performed. The preliminary dive shall also remove any debris in the bottom of the canal prior to the start of construction. A post dive shall be performed at the completion of work in the construction area. Both the preliminary and post dives shall be video- taped and a copy sent to CAWCD.

12. Temporary Water Permit – The purpose of a temporary water permit is for dust control, military and livestock. Presently, a fee of $3000 is charged for the review of the temporary installation and the initial 5 acre feet of water. Additional water may be purchased if excess water is available. A sketch showing the type and size of the pump, its location and any piping is required. Temporary water permits are reviewed and evaluated on an annual basis. For additional information see the following website: http://www.cap-az.com/Lands/CAPTemporaryWaterUse.aspx

13. CAP Trail – is a multi-use recreational trail along the entire length of the canal. The trail is 10 to 20 wide and usually located just outside the canal right (when looking downstream) security fence. For additional information see the following website: http://www.cap-az.com/Lands/CAPTrail.aspx

3.1 SAFETY

All work on CAP property shall comply with the most current Occupational Safety and Health Administration standards, CAP Safety Manual or Reclamation Health and Safety Standards, whichever is more stringent. These documents can be found on the CAP website under contracting/safety.

3.2 SECURITY

The CAP property shall be secure at all times from non-authorized personnel. Gates and fences shall be kept in good condition at all times. Any damage to fencing shall be reported to the CAP Security Desk (623 869-2393) and repaired before the end of the business day.

Gates shall be kept locked unless manned. Contractors may obtain a key (s) that will open padlocks on CAP security gates after completing a Key Authorization form from the CAPCD Protective Services Department. Upon completion of the project the contractor shall return all keys that were obtained. The contractor shall be charged a fee for unreturned keys.

3.3 SURVEY DATA REQUIREMENTS

Engineering and/or land survey drawing shall contain the appropriate registered engineer's or land surveyor's stamp and signature.

A license may be required for visual inspections, ground and aerial surveys, or potholing that requires physical entrance onto a CAP property.

A professional land surveyor shall tie into a minimum of two (2) existing CAP property/boundary monuments. CAWCD will provide the location of the closest monuments of the project area upon written request.

4.0 CONSTRUCTION ACROSS CAP PROPERTY

CAP property is crossed by all types of utilities, roads and drainage facilities. The following subparagraphs address General Items, Requirements and Conditions that occur in most crossings of CAP property and are followed by more specific crossing requirements. These are guidelines and may not cover every specific feature of future crossings.

4.1 General Items, Requirements and Conditions

4.1.1 Drainage

If drainage features are to be modified during construction, detailed drawings showing the proposed drainage /and restoration shall be submitted with the application for review and approval. The applicant is responsible for the care and handling of storm water runoff during construction.

The applicant shall not divert surface runoff toward CAP canal or canal embankments. Storm surface runoff shall use detention basins outside of CAP's property. Lined drainage channels shall be designed to transfer flow from the detention basins to the existing cross drainage facilities that drained the original area. Also refer to "4.6 Storm Water Cross Drainage" for further requirements.

4.1.2 Warning Tape

Warning tape shall be required over below-ground utilities situated within CAP's property and shall be a minimum of 18 inches above the utility and between 18 and 30 inches below the ground surface. Warning tapes shall conform to the following specifications:

1. For potable water lines, the warning tape shall be a 3-inch-wide blue detectable tape imprinted with "**CAUTION BURIED POTABLE WATER LINE**."
2. For non-potable water lines, the warning tape shall be a 3-inch-wide purple detectable tape imprinted with "**CAUTION BURIED NONPOTABLE WATER LINE**."
3. For sewer and storm drain lines, the warning tape shall be a 3-inch- wide green detectable tape imprinted with "**CAUTION BURIED (type) LINE**."
4. For gas, oil, steam chemical lines, the warning tape shall be a 3-inch-wide yellow detectable tape imprinted with "**CAUTION BURIED (type) LINE**."
5. For telecommunications, telephone, and television conduit(s), the warning tape shall be a 3-inch-wide orange detectable tape imprinted with "**CAUTION BURIED (type) CONDUIT**."
6. For electrical, street lighting, and traffic signal conduit(s), the warning tape shall be a 3-inch-wide red detectable tape imprinted with "**CAUTION BURIED (type) CONDUIT**."

4.1.3 Tracer Wire

All underground utilities that cross CAP property shall be identifiable using underground detection equipment. The suggested method is to place a 12 ga. bare copper tracer wire in the utility trench with junction boxes at the CAP fences.

4.1.4 Potholing

Potholing is the practice of exposing underground utilities to determine the horizontal and vertical location of the utility. Vacuum excavation is the CAP preferred method of potholing.

The resultant elevation information shall be delineated on the plan and profile view and labeled as:

Potholed Elevation XX.X Surface Elevation XX.X

The pothole excavation shall be filled in or protected, prior to departing the site each day. The presence of a CAP inspector may be required throughout the excavation process. But this presence in no way relieves the applicant or their contractor of responsibility.

4.1.5 Geo-technical excavations

A plan showing the location and depth of any Geo-Technical/Soil Boring shall be submitted to CAP for approval. All excavations shall be filled in with a ½ sack cement slurry unless otherwise directed by CAP before departing the site. The contractor shall submit boring logs to CAP for their records.

4.1.6 Trenching & Excavations

Trench excavation shall comply with the most current Occupational Safety and Health Administration standards, CAP Safety Manual or Reclamation Health and Safety Standards, whichever are more stringent.

Trenches and/or excavations 4 feet or deeper shall be sloped back or shored to meet site conditions.

Excavations 20 feet or greater shall contain shoring reviewed and approved by a professional engineer registered in the State of Arizona.

4.1.7 Backfilling

Trench backfill shall be placed in 4- to 6-inch lifts, if hand compacted or no more than 8-inch lifts if power compacted. Trench backfill within CAP's property shall be compacted to 95 percent relative compaction per ASTM D 698, Standard Proctor. Mechanical compaction using heavy equipment (greater than 2,000 pounds) shall not be used within 24 inches of the CAP pipeline, canal or siphon. Flow able fill (or controlled low strength material) shall be substituted for compacted pipe embedment under canals and may be used when crossing pipelines.

4.1.8 As-Builts

The licensee agrees to deliver to CAWCD "As-Built" drawings of a quality meeting accepted industry standards within ninety (90) days after completion of the licensee's construction project. Such drawings shall be received and approved by CAWCD before CAWCD will order the federal appraisal or federally-contracted appraisal and prepare the required post-construction land use license.

The licensee or licensee's contractor shall procure and maintain during the term of the license, a performance bond to insure the timely submission of the "As-Built" drawings in accordance with the provision identified below. The bond shall be for an amount not less than $10,000, and shall name CAWCD as the Obligee.

The "As-Built" submittal shall contain the following information and be placed electronically on a CD-R and three sets of half size (11" x 17") hard copies:

1. Comma Separated Values (CSV) files with Grid Coordinate Data to the 10th of a foot in NAD83 coordinated system, generated by a registered surveyor that

contain, at a minimum, the point number, northing, easting, elevation, description/point name, feature type, feature material, and feature size.

2. A professional land surveyor shall tie into a minimum of 2 CAP existing property/boundary monuments. CAWCD will provide the location of the closest monuments of the project area upon written request.
3. Survey points with digital photos shall be taken every hundred (100) feet or any point where there is a change in either the vertical or horizontal alignment. The photos need to be labeled to match the point information and submitted with the survey information.
4. A complete set of drawings signed, sealed and dated by a Professional Engineer or Land Surveyor registered in the State of Arizona that include the precise location and installation specifications of the utility, facility and/or structure by recording any deviation from the original design drawings. The horizontal and vertical datum information shall also be included. All drawings shall also show the CAP property boundary and License/Easement limits.
5. Utilities shall be surveyed and plotted every 100 feet of straight run, at each direction change and each elevation change. These point coordinates and elevations shall be recorded on the As-Built drawings and submitted at the completion of the project.

If the three sets of half size (11" x 17") hard copy and a electronic copy on a CD-R of "As-Built" drawings are not received within ninety (90) days after the completion of the project, CAWCD may notify the surety company and request the "As-Built" drawings be completed within thirty (30) days or have the "As-Built" drawings completed by a third party and seek reimbursement by forfeiture of the bond penalty.

4.1.9 Underwater Canal Liner Inspection Dives

Any construction work over, under or near the CAP canal that may damage the canal liner shall be conducted after a Pre-Construction Dive. The inspection area of the dive will be a minimum of 50 feet upstream and downstream of the construction area unless otherwise directed. The divers shall video tape the entire inspection of the canal liner condition and submit a .avi formatted CD to CAWCD. The dive inspection shall be performed by a professional dive company that is acceptable to the CAWCD. The dive company will submit a dive plan with a Job Hazard Analysis (JHA) to CAWCD for approval prior to performing the dive inspection.

After completion of the construction work over, under or near the CAP canal a Post-Construction dive inspection shall be performed. All of the requirements listed for the Pre-Construction Dive will also be required for the Post-Construction Dive.

4.2 Utilities Crossing Under the Canal

Utilities shall be installed perpendicular (between 70 and 90 degrees) to the canal alignment unless specifically approved. The utility shall extend completely through the CAP secured area. These minimums do not relieve the applicant’s engineer from performing an onsite investigation or other work to determine local conditions that may require additional pipe/conduit length.

The contractors shall be responsible for any damage to the canal section during the construction of a crossing, and the contractor shall repair the damage at their own expense.

If an emergency situation develops during construction, the contractor shall immediately notify the CAWCD Control Center at 623 869-2530. CAWCD shall approve further work at that point.

Any pressure lines installed within CAWCD's property shall have adequate thrust restraint at bends and valves. Specified design pressures and thrust restraint calculations shall be provided to CAWCD to confirm the design configuration.

A geotechnical report shall be submitted with the application for review prior to approval of the proposed utility crossing. There are a number of different methods (i.e. Bore and Jack, Pipe Ramming) that can be used to cross under the CAP canal. The following are a list of conditions that shall be incorporated into plans when crossing under the CAP canal.

NOTE: All conduits, electrical and communication, and pipe lines are referred to as "utilities" in these guidelines.

4.2.1 Bore and Jack or Pipe Ramming Methods

1. A casing pipe is required for any utilities placed under the CAP canal. Plans shall show carrier/casing pipe type, diameter, and thickness. Casing pipes shall be steel pipe (American Water Works Association [AWWA] C-200) and have 1/4-inch minimum wall thickness. Applicants shall provide the type of carrier pipe and appropriate bell dimensions for said carrier pipe to verify annular clearances.
2. When installing pipe while the canal is watered, a minimum of 10 feet of clearance between the top of the casing pipe and the bottom of the canal shall be maintained. The clearance maybe increased due to geological conditions.
3. Provide a minimum of 3 inches of clearance between the carrier and casing pipes at all points (including bells).
4. A bulkhead or effective sealing device shall be provided at both ends of each casing pipe to seal the annular space between the two pipes. Vent pipe shall be included to allow ventilation and reduce the risk of condensation buildup and flooding.
5. As a result of the installation process, an annular void is usually created around the outside of the casing pipe. Provisions shall be made to pressure grout or effectively seal (e.g., bentonite slurry) this void space.
6. To contain the slurry during installation, jacking & ramming pits shall be constructed so that natural ground or a compacted dike is entirely around the pit to an elevation at least 1 foot above surrounding grade.
7. If the contractor elects to install shoring in the jacking or ramming pits, all shoring designs shall be prepared by a Professional Engineer, registered in the State of

Arizona, knowledgeable in said type of work. A copy of the shoring designs shall be submitted to CAWCD.

8. Jacking & ramming pits shall be backfilled with native material and mechanically compacted to 95 percent of the maximum dry density per ASTM D-698.
9. The minimum distance between two jacked or rammed pipes shall be 10 feet.

4.2.2 Horizontal Directional Drilling (HDD)

Directional drilling under a canal shall follow the MAG Standards Section 608 Horizontal Directional Drilling. The following exceptions to Section 608 shall apply when drilling under the CAP canal.

1. The minimum clearance of 10 feet to the bottom of the canal lining shall be maintained for utilities with less than a 12-inch outside diameter. Larger utility crossings shall be considered on an individual basis and may require additional clearance from the bottom of the canal lining.
2. Paragraph 608.4.3 Delete the last sentence. Second to last sentence is changed to read: Any change if elevation of the concrete canal liner greater than ½" shall be considered excessive and shall be repaired at the Contractor's expense.
3. Paragraph 608.5.4 Paragraph 6 shall read: Maintain a two foot (2') minimum….
4. Table 608-3 the minimum separation for wet utilities shall be changed from 2' to 10'. The minimum separation for dry utilities shall be changed from 1' to 2'.

When horizontal directional drilling (HDD) or other trenchless methods are used, canal seepage conditions may be aggravated by the collapse of the canal foundation material into the annular void between the bore and pipe. Penetration through the top stratum of fine-grained materials may concentrate seepage at those locations. Pipe installed with trenchless methods shall proceed only after CAWCD has completed a comprehensive evaluation and approved of the following:

1. Comprehensive understanding of the subsurface soil and groundwater conditions to a minimum depth of 20 feet below the lowest pipe elevation
2. Locations of the HDD pipe penetration entry and exit
3. Construction procedure
4. Allowable uplift pressures
5. Onsite quality control and quality assurance monitoring during construction operation
6. Grouting of the pipe annulus
7. Backfilling of any excavated areas
8. Repair and reinstatement of the construction staging areas

4.3 Underground Utilities Crossing a CAP Underground Pipeline

Procedures, excavation plans, schedules, as well as type and weight of the construction equipment to be used for crossing the CAP pipeline shall be submitted.

1. For utilities crossing above the CAP pipeline, the vertical clearance between the utility and CAP pipeline shall be a minimum of 24 inches. Crossing under the CAP pipeline shall have a minimum clearance of 10' for utilities that are 12" or smaller in diameter. Larger utility crossings shall be considered on an individual basis and may require additional clearance from the bottom of the CAP pipeline.
2. The location of the CAP pipeline and the communication and control cables throughout the area of the proposed construction shall be shown on the plans. Prior to CAWCD issuing a use authorization or consent document, the pipeline and the cable(s) shall be located and exposed by potholing. The pothole locations shall be shown on the drawings. The pothole elevations shall be referenced to CAP stationing or milepost.
3. Drawings shall contain the following information:
    a. CAP milepost or station at each proposed crossing, pipeline size and location, and type of utility or material transported.
    b. Maximum utility operating pressure, type of pipe and joints, maximum test pressure and description of test procedures, wall thickness, and utility pipe classification.
    c. Type of sleeve/casing pipe including diameter, joints, distance between spacers, fill material inside the casing, and wall thickness.
    d. Protective coatings and corrosion control measures.
    e. Location of nearest shutoff valve on each side of the crossing.
    f. Location and details of thrust restraint.
    g. Design code(s) used for utility crossing.
    h. Location, including depth of the CAP pipeline and the communication and control cables.
    i. Other existing utility easements in the immediate vicinity.
4. Warning tape is required over trenched utilities. Refer to “4.1.2 Warning Tape” for further requirements.
5. For trench excavation and backfill requirements refer to “4.1.6 Trenching and Excavation.”
6. Embankments shall not be permitted within CAP’s property where underground pipeline exists.

4.4 Vehicular, Pedestrian, and Utility Bridge Crossing CAP Property

1. New bridge crossings (vehicular, pedestrian, and utility) shall be perpendicular (between 70 and 90 degrees) to the centerline of the canal or pipeline and at

locations approved by CAWCD. Exceptions to the policy may be considered on an individual basis.

2. Public use bridges in urban areas shall be spaced no closer together than 1/2 mile apart. This is to ensure O&M operations are not overly restricted.
3. Bridge crossings shall be of free span design. Consideration of any anticipated (known or ongoing) canal subsidence issues, anticipated raising of the canal lining, or anticipated increases in the canal's high water level shall be made. Bridges shall be designed and constructed in a manner to allow unobstructed travel along the canal and/or pipeline. Future bridges shall have 14'-6" vertical clearance under the bridge to allow CAP vehicles to travel on the O&M roads unrestricted. A 12 to 20 foot wide pedestrian/equestrian trail runs just outside the canal right security fence. The vertical clearance under a bridge for the pedestrian/equestrian trail is 12'-0". No at grade crossing are permitted.

   Utilities that cross above the canal and then go below the O&M roads may be constructed in the CAP property. The minimum vertical clearance between the bottom of the utility bridge and the top of the canal lining shall be 4 feet. The minimum horizontal clearance from the face of the abutment to the top of the canal lining shall be 4 feet.
4. CAP canal O&M access roads shall intersect public roads at bridges at right angles for proper visibility. This may require the applicant to acquire additional PROPERTY for use if the existing CAP property is not sufficient. American Association of State Highway and Transportation Official (AASHTO) criteria for sight distances at the intersection of O&M roads and roadways at new bridges shall be met to allow O&M vehicles to cross them safely.
5. The submitted plan drawings for the bridge shall contain the following information:
   a. Superstructure, abutments, railings, embankments, slope paving and drainage, including details and sections
   b. Type of materials (concrete, steel, timber, etc.) used for different members
   c. Details of cast-in-place foundation piles, if any, on both sides of the canal
   d. Design loadings
   e. Design standards on which the bridge is based (AASHTO, etc.)
   f. A road for construction and storage area access.
6. The calculations and specifications for the bridge shall be submitted to CAP for review.
7. All turning radii used onto a CAP O&M road shall comply with the provisions in the 67-foot wheelbase (WB-67) truck turning template, AASHTO manual on Geometric Design of Highway and Streets.
8. Details of any proposed utilities to be attached to an existing bridge include:
   a. Anchor bolt locations shall not intercept the critical reinforcing steel of the bridge.

b. Utilities shall be placed and anchored under bridge decks and through utility openings, if they are present. The utility shall be placed off center in the utility opening, if possible, to allow for future utility additions.

c. If an expansion joint is used in the pipeline, the joint shall be placed near the bridge deck expansion joint.

d. Holes through bridge concrete or abutment and retaining walls for passage of utilities shall be allowed by core drilling. The annular space between the utility and core hole surface shall be completely filled with an elastomeric sealant to prevent loss of material or water piping from behind the wing walls and abutments.

e. Submit calculations showing the effects of the weights of the proposed utilities on the load carrying capacity of the bridge for CAWCD review.

f. Intermediate supports for the utility shall withstand the same seismic load considerations as the bridge.

g. Load limit signs shall be placed adjacent to the bridge, as required under AASHTO criteria.

h. Beam guardrails shall be installed at bridges and bridge approaches, as required under AASHTO criteria.

9. CAWCD shall not be responsible for modifications to CAP existing property, bridge O&M approach roads, existing and additional fencing, gates, signs, cattle guards, etc.

4.4.1 Drilling and Piling Plans

Driving piles shall not be permitted. Any abutment foundation support piles shall be drilled and cast-in-place.

1. At a minimum, the applicant's drilling and piling plan shall include:
   a. Drilling methods and equipment
   b. Methods for preserving existing foundation material
   c. Methods and equipment to determine the presence of quick soil conditions or scouring and caving
   d. The proposed method for casing installation and removal if casings are used
   e. Methods and equipment for accurately determining the depth of concrete and actual or theoretical volume placed
   f. A plan showing the location and depth of any Geo-Technical/Soil Boring shall be submitted to CAWCD for approval. All excavations shall be filled in with ½ sack cement slurry unless otherwise directed by CAP before departing the site. The contractor shall submit boring logs to CAWCD for their records.

4.5 Roads and Surface Crossings

Road and other surface crossings over CAP pipelines and siphons shall need to comply with the following requirements. Drawings and specifications will be reviewed and approved before any construction is started.

1. Proposed temporary or permanent modifications to the existing cover over CAP pipelines shall be subject to review and approval by CAWCD. Design parameters for roadway, parking lot, and driveway crossings over the pipe shall also be subject to review and approval by CAWCD.
2. When a CAP pipeline system is being crossed the applicant shall analyze the crossing to show pipe load carrying capability. If the load carrying capability of the pipeline is exceeded options for reducing the load over the pipe shall be submitted.
3. The applicant shall submit a grading plan as part of the application. If the applicant intends to modify existing drainage features during construction, detailed drawings showing the proposed drainage replacement/restoration shall be submitted with the application for review and approval. For additional information refer to 4.6 Storm Water Cross Drainage.
4. Streets, roads, or parking areas crossing CAP pipeline easements are permissible. All streets, roads, and parking surfaces are to be asphalt or other flexible pavement. Depressed curbs or driveways shall be provided for CAP vehicular access when new roads cross CAP property. Repair of the CAP pipeline/siphon may occur in the future. These repairs may result in the removal or damage of existing pavement and curbing. CAWCD shall not be held responsible for replacing damaged or removed pavement or curbing.
5. Roadway ditch drainage shall not be allowed to flow into the canal. Drainage shall be retained and released in a controlled way to maintain peak discharges that are less than any peak historical runoff rate before these modifications. Applicants shall direct drainage to an original sub-basin cross drainage culvert or over chute.

4.6 Storm Water Cross Drainage

1. Upstream development impacts that change historic natural drainage volumes and peak flow rates need to be analyzed and evaluated. Development re-grades and revised drainage sub-basins, revised ground cover from constructing roads, parking areas, and buildings may result in the need to change the cross drainage features (culverts and/or over chutes) along CAP canals.
2. A hydrologic study shall accompany all plans that modify the existing drainage across and/or along CAP property. The study or report shall show the proposed flows of the canal and the associated crossings. The drainage study or report shall show that the downstream system can accept the flows without creating any flooding to properties adjacent to or downstream of the canal.

3. All drainage crossings, whether existing or proposed, shall carry the peak runoff of a 100-year event while preventing any storm water from entering the canal and/or ponding against the canal embankment.
4. Urban runoff shall not be allowed to enter into, or drain onto, CAP's land. All flows generated outside CAP's property shall enter the storm drain system prior to entering CAP's property. Piped connections are preferred, but concrete-lined channels may be acceptable upon CAP's review.
5. New crossing under the canal shall be designed with 10 feet vertical clearance from the top of the cross drainage structure to the bottom of the canal (or liner). The structure shall extend completely across CAP's chain link fence secured area.
6. New overcrossings of the canal shall have 4 feet of vertical clearance from the top of the liner and 4 feet of horizontal clearance from the support abutments to the outside edge of the canal lining. The O&M road drainage structure shall be structurally capable of withstanding highway-legal vehicle loadings and provide at least 1 foot of cover in the roadway.
7. Pipe crossing barriers shall be installed on all pipe overcrossings where required to secure the CAP property.
8. All drainage flow shall be discharged to a downstream storm drainage system owned, operated, and maintained by a public agency (such as a city or county) or into areas such as channels, roadways, parks, wetland basins, or other non-private lands that can accept the concentrated flows from the drainage crossing.
9. All drainage from upland property shall be collected by the applicant's installed system of curbs and inlets within their property and discharged into a non- CAP public agency's drainage system.
10. New drainage system designs shall not use ponding against the existing canal embankment for temporary detention of storm runoff that will not immediately pass through existing or new crossings.

    Proposed permanent detention facilities adjacent to CAP's property shall include engineered fill beyond the canal boundaries to provide, at a minimum, a fill-width maintenance access roadway between the canal property and the basin. The design shall provide for sufficient freeboard to contain the 100-year event within the proposed basin adjacent to CAP's property and shall have adequate protection from seepage and erosion.
11. Unless CAWCD specifies otherwise, the applicant shall remove or plug and abandon existing drainage crossings that are not used by the development unless they are shown to provide an additional measure of safety for the canal by reducing the likelihood of spill into the canal caused by extreme runoff flows. Otherwise, these crossings shall remain in place for CAWCD's benefit and will not require ownership transfer to a public agency.

    These crossings shall discharge into the non- CAP public agency's storm drainage systems or into areas such as channels, roadways, parks, wetland

basins, or other non-private lands that can accept the concentrated flows from the drainage crossing in the case of an extreme runoff event.

Grading in CAP property shall be preserved or revised to direct extreme runoff flows into these unused drainage crossings without allowing said flows to enter into the canal until the crossings reach their capacity.

4.7 Green Up Areas & Reach 11 Dike Crossings

The Green-up areas are contained within a zone between the toe of the upslope dike and the upslope right-of-way fence that was left in place after the aqueducts were constructed. This land has been set aside by the Bureau of Reclamation as mitigation for constructing the CAP canal. The green-up area retains water behind the dike or waste embankment and allows vegetation to grow and stay green. CAWCD shall protect the green-up area from land use practices that would degrade the wildlife value or impact archaeological sites. Roads or structures built in the green-up area shall not be allowed to take away retention capacity. Therefore, the green-up has to be modified in some manner to balance the lost retention. Before a license can be issued for a project in the green-up area an archaeological and wildlife impact study shall be completed. The area behind the Reach 11 dikes is also Green Up Area. The Reach 11 dikes are located on canal left between Cave Creek Road in Phoenix and Shea Blvd. in Scottsdale. There are four parts to the Reach 11 dikes:

Dike 1- Cave Creek Road to Tatum Road

Dike 2 - Tatum Road to Scottsdale Road

Dike 3 – Scottsdale Road to Loop 101

Dike 4 – Loop 101 to Shea Blvd.

For more details on how to build roads and utilities across the Green-Up Areas and Reach 11 Dikes see Appendix A.

4.8 Developments

Urban development is becoming more dominant adjacent to CAP's property and facilities. These are general guidelines for accommodating new development.

1. Where subdivision development is adjacent to the canal, fencing shall include these characteristics:
    a. Temporary chain link fences shall be installed prior to removing any portion of existing fences.
    b. Upon completion of grading for drainage and other work, fencing shall be installed along the subdivision's boundary length of the adjacent ROW. The fence shall be constructed to project standards.
    c. The new fence shall be located 1 foot outside of CAP's boundary. The fence location shall be shown on the improvement plans.
2. Permanent structures shall not be permitted within CAP fee-owned linear property.

3. Use of CAWCD pipeline easements as part of residential subdivision lots shall not be allowed. Easements may be included within the subdivision greenbelt or similar use areas. Vegetation and approved items within the CAP easement are subject to removal for CAWCD maintenance of the pipeline and shall not be the responsibility CAWCD to replace.
4. Drawings shall include all proposed improvements (i.e., streets, utilities, landscaping, etc.) within, and adjacent to, CAP's property.
5. Vegetation shall not be planted on CAP property.
6. All streets, roads, and parking surfaces shall be asphalt or other flexible pavement. Depressed curbs or driveways shall be provided for CAP vehicular access when new roads cross CAP property. Repair of the CAP facilities may occur in the future. These repairs may result in the removal or damage of existing pavement and curbing. CAWCD shall not be held responsible for replacing damaged or removed pavement or curbing.
7. Where fencing is proposed within CAP easements, a minimum 16-foot-wide gate shall be provided for CAWCD access.
8. Pipelines containing sewage, oil, gasoline, natural gas, or hazardous materials shall only cross perpendicular (between 70 and 90 degrees) to the CAP facilities and be installed with the necessary safety measures and separation clearance as required in "4.6 Utility Crossing."
9. Electric poles, etc., shall be installed at the maximum distance possible from the edge of the pipeline or canal.

4.9 Overhead Lines Crossing

Overhead wires that are proposed to across CAP facilities shall be in accordance with the following table.

Power Line Clearances

Voltage kV	A OVER CANAL MAINT. ROADS 120°F. (FT.)	B OVER DIKES 120ºF. (FT.)
500	50	39
345	45	34
230	41	30
161	39	28
138	38	27
115	37	26
69	36	25
50 & UNDER	35	21
TELEPHONE & OTHERS	27	18

CAWCD has the following requirements for overhead crossings:

1. Poles or towers shall not be allowed within CAP's property.
2. High voltage, direct current power lines shall not be permitted to encroach on CAP property, except in unusual circumstances and with proper cathodic protection considerations.
3. Overhead electrical and communication lines shall cross perpendicular (between 70 and 90 degrees) to the centerline of the CAP facility.
4. If necessary, fence grounding is to be provided for existing fence lines, especially under power transmission lines. See CAP Standard fence grounding drawing: STD-C-C06756.
5. A warning sign shall be provided that shows the clearance. The warning sign shall face oncoming traffic and state, "DANGER, HIGH VOLTAGE OVERHEAD."
6. Aerial marker balls shall be placed over the center of the Operation & Maintenance (O&M) roads. The balls shall be a minimum of 2 feet in diameter and orange or orange and white in color.

4.10 Improvements Crossing Transmission Easements

1. Minimum National Electrical Safety Code (NESC) clearances shall be maintained at all times. Also, all NESC and NFPA lOE safety rules shall be followed.
2. Developer and contractors shall comply with Chapter 2. Article 6.4 of Arizona Revised Statues 40-360.41-45 (Overhead Power Line Safety Law).
3. New transmission lines that cross existing CAP transmission lines shall only cross perpendicular (between 70 and 90 degrees) to the CAP transmission line and be installed with the necessary safety measures and separation clearance.
4. A 50-foot radius (100-foot diameter) clear-zone area around the transmission towers/poles shall remain open and level for safety and maintenance needs. This area shall be kept completely clear since it is necessary for set-up of large maintenance equipment near and around the structures. The transmission line towers/poles shall also be protected from soil erosion.
5. No trees shall be located within CAP's property. Vegetation shall not exceed 10 feet in height at maturity, and shall preferably be planted 50 feet away from structures. CAWCD shall not be held responsible for any damage to vegetation/irrigation caused by the large maintenance equipment. Developer shall comply with any additional National Electric Reliability Council (NERC) and Western Electric Coordinating Council (WEEC) requirements to protect the electric grid.

6. No excavation/trenching shall be performed within 20 feet of any CAP transmission line towers/poles.
7. The gradient within the easement area shall not be steeper than 6:1 (run: rise). Large heavy-line maintenance equipment requires a smooth transition from any roadway onto the right-of-way area. Rolled curbs or dedicated drives, a minimum of 16-feet wide, shall be provided along any roads within the width of CAP's property. This shall include, but is not limited to, water drainage areas, transition from all roadways, at gate locations, as well as along any access-way to the transmission line structures and mid-span areas.
8. Overnight or long-term storage/parking is not allowed within CAP's easement area.
9. All conductive improvements, such as light poles and metal railing, to be installed within the easement are required to be grounded as part of the construction process.
10. Signage within CAP's easement shall not exceed 10 feet. Metal signs shall be properly grounded.
11. Adequate and appropriate cathodic protection shall be provided for buried metal pipelines; i.e., water and sewer lines.
12. As-Built drawings for new transmission lines crossing existing CAP transmission lines shall state as a minimum the following:
    - The number of degrees from perpendicular that the lines cross
    - The clearance between the natural grade and the newly install power lines
    - The clearance between the existing and the new power lines
    - The north and east coordinates of the poles/towers on either side of the CAP property.
    - The line voltage of the crossing transmission line.
    - The location of signage stating the clearance beneath the new transmission line

4.11 Turnouts

A turnout is a connection to the CAP canal or pipeline that routes water from the CAP canal or pipeline to a water user's facility. The water user designs and builds the turnout to CAWCD specifications. The construction of the turnout is performed by the water user's contractor in coordination with the CAWCD. A maintenance agreement is developed between the CAWCD and the water user. In the maintenance agreement it is stipulated which buildings and equipment will be operated and maintained be CAWCD and which buildings shall be maintained by the water user. The equipment to be owned, operated and maintained by CAWCD is then transferred to CAWCD.

Each one of the different types of turnouts shall have a flow meter vault and a control building. The flow meter vault is a concrete structure with an equipment hatch and personnel hatches with intrusion alarms, a sump pit, ladders and platforms. Flexible couplings shall be installed in the pipe line on both sides of the flow meter vault for differential settling. The following equipment shall be placed in the flow meter vault.

1. Flow meter pipe spool with transducer- per CAWCD specification. The flow meter pipe spool shall have mechanical couplings on each side of flow meter transducers for removal. Signals from the flow meter and intrusion alarms shall be transmitted to CAWCD Headquarters.
2. Exhaust Fan
3. Sump Pump

The concrete control building shall be constructed and contain the flow meter controls, a programmable logic controller (PLC), ethernet router, isolation valve (slide gate) controls and intrusion alarms. A CAP approved flow meter with 0.5% accuracy shall be installed. Signals from the flow meter, isolation valve, exhaust fan, sump pump and vault intrusion alarms for both the flow meter vault and control building shall be transmitted to the CAWCD Control Center.

4.11.1 Canal Gravity Flow Turnouts

A gravity flow canal turnout usually consists of an intake structure built into the side of the canal, a flow meter vault that is partially underground and an above ground control building.

The Intake Structure is a concrete structure that contains trash racks, stop logs, motor operated isolation valve (slide gate), and a differential pressure instrument to measure the pressure down across the trash racks.

Cathodic Protection shall be designed and installed on trash racks and pipe that extends from the intake structure to the flow meter vault.

A cofferdam dam shall be designed and installed to protect the intake structure work area and allow water to flow down the canal. Canal levels may be lowered as long as water deliveries are not impacted.

4.11.2 Pumped Water Turnouts

A pumped water turnout is a turnout that uses pumps to remove the water from the CAP canal. The pumps maybe placed on a bridge that spans the canal or in a pump pit built into the side of the canal.

Once the water leaves CAP property it shall not be allowed to drain back into the canal.

The O&M road shall not be blocked in any manner by the pump discharge piping.

The pump running status shall be transmitted to the CAWCD Control Center.

4.11.3 Pipeline Turnouts

The CAP system has a number of places where the CAP water travels through pipes or siphons. Connections to these pipelines/siphons require nearly all the features/equipment listed in 4.10 and a few additional ones.

A transient analysis shall be performed by the water purchaser to ensure that no damage will be done to the CAP facilities by the operations of the water purchaser's turnout.

Cathodic Protection shall be designed and install on pipelines that are located in CAP property.

5.0 CATHODIC PROTECTION REQUIREMENTS

Unless approved in writing by CAWCD, metallic pipelines or those containing metallic reinforcement (e.g., reinforced concrete) installed within CAP's property shall have a suitable bonded dielectric coating and be cathodically protected. Impressed current cathodic protection rectifiers and deep-well anode systems shall not be permitted within CAP facilities without prior approval from CAWCD Cathodic Protection Engineer. All submittals shall include details of the cathodic protection system (CPS) and its appurtenances.

All existing CAP cathodic protection test stations, cables running to these stations, rectifiers, anode beds, and any other appurtenances shall be located prior to any grading or excavation. The test stations shall be staked and flagged. The test stations, cables running to these stations, any anode beds, etc., shall be suitably enclosed or protected during construction to prevent damage. No re-location or modification of the test stations, cables, anode beds, etc., is allowed without prior approval from CAWCD Cathodic Protection Engineer.

Generally, the CPS to the proposed pipeline shall be the sacrificial anode type unless the proposed installation continues an existing pipeline that uses impressed current type of cathodic protection.

A means of monitoring the effectiveness of the CPS on the proposed pipeline shall be provided within CAP's property. The number of anodes and test stations will differ with each project. Test stations shall be located at every anode bed connection and shall not be more than 1,000 feet apart. A test station shall also be located where any metallic pipeline crosses over or under a metallic CAP pipeline, metallic fence, other metallic structure embedded in the ground, or comes within 20 feet of a CAP structure on or embedded in the ground. Both the proposed cathodically protected pipeline and the CAP pipeline shall be monitored regularly using these test stations. Monitoring results shall be reported to CAP Cathodic Protection Engineer.

In addition, the owner of the proposed crossing pipeline shall investigate and mitigate any adverse potential shift caused by the proposed pipeline on the CAP pipeline. Owners of proposed crossing pipelines shall return CAP pipelines to their original electrochemical potentials or to more benign potentials. Mitigation measures shall be approved by CAWCD Cathodic Protection Engineer. The effectiveness of mitigation

measures shall be confirmed in the presence of a CAWCD representative following installation.

For those pipelines under ADOT regulation, the application and monitoring of the CPS shall conform to Title 49 CFR, Part 195, any special provisions of this guideline, and the provisions of NACE International RP 0169, in that order. For other pipelines, any special provisions of this guideline shall take precedence, followed by the provisions of NACE RP 0169.

If a casing pipe required for the installation, the contractor shall submit the design to conform to Title 49 CFR, Part 195, NACE RP0169 and NACE Standard RP0200-2000, Standard Recommended Practice Steel-Cored Pipeline Practices.

REFERENCES

Title 49 CFR, Part 195.

Reclamation Manual, Directive and Standards LND 08-01, Land Use Authorizations, http://www.usbr.gov/recman/lnd/lnd08-01.pdf

GP Region Billings MT – Standard Crossing & Clearance Requirements, Utility Lines and Cables, drawing 40-600-51. The office also uses a Preliminary Project Description Form and a Special Use Permit.

PN Region Burley ID – Overhead and underground crossing clearances.

Reclamation 2005. Preliminary drawing 103-D-1700 that provides general requirements for installation of crossings, June 2005.

Policy on Geometric Design of Highway and Streets, American Association of State Highway and Transportation Officials (AASHTO) Fifth Edition, 2004.

U.S. Army Corps of Engineers – Engineering and Design, Design and Construction of Levees EM 1110-2-1913, 30 Apr 2000, CECW-EG Washington, DC 20314-1000.

Central Arizona Project, Reach 11 Guidelines.

NACE Standard RP0200-2000, Standard Recommended Practices "Steel-Cored Pipeline Practices"

NACE, International RP 0169, “Standard Recommended Practice – Control of External Corrosion on Underground or Submerged Metallic Piping Systems.”

GLOSSARY

Bored and jacked – This terminology is a general way of referring to a family of trenchless methods.

Bridge, class A – Vehicular bridge used by the public. May or may not be owned by the CAP.

Land Use License – License required to across CAP fee-owned lands.

Detention basin – An artificial flow control structure used to contain flood water for a limited period of a time, thereby providing protection for areas downstream. Detention basins provide a way to reduce storm peak flows, while retention basins hold water for an extended period of time. These basins are generally a part of a larger engineered flood water management system.

Potholing – The practice of digging test holes to expose underground utilities (e.g., cables) to determine the horizontal and vertical location of these utilities.

Trenchless methods – Procedures for installing pipe without using traditional trench cut and cover methods. These trenchless methods may be referred to as bore and jack, tunneling, horizontal directional drilling, and micro tunneling, among others.

Water conveyance facility – Canal, ditch, pipeline, drain, levee, open or closed laterals, and similar facilities and their associated appurtenant features.

APPENDIX A

GUIDELINES FOR GREEN UP AREAS & REACH 11 DIKE CROSSINGS

Purpose

These guidelines are intended to assist governmental agencies and private developers in preparing project concepts and designs that do not adversely impact the Central Arizona Project canal, dikes, and dike detention and drainage basins, and are consistent with current land use and land-use plans. Projects shall be submitted for approval early in the planning process. An exchange of information shall continue through final designs.

Glossary

Detention basin - The flood detention reservoir is located behind a dike at or below the dike crest elevation.

Drainage basin- The land area that contributes runoff to a detention basin.

Inflow design flood - The characteristics of basin runoff which the discharge, retention, or detention structures are designed to control safely.

Critical component - A structure built or a condition created or changed by the new work that can reasonably cause catastrophic failure of the dike or significant loss of the essential design function.

Live storage -That volume which captures and stores water that will flow, by gravity, to and through the dike outlet structures into the CAP aqueduct.

Dead storage - That volume which captures and stores water that cannot flow, by gravity, to and through the dike outlet structures into the CAP aqueduct. More specifically, dead storage exists below the invert elevations of the outlet works conduits. Each basin has a unique elevation where dead storage exists.

Interagency Coordination

A Construction Period Land-Use License shall be issued by the Central Arizona Water Conservation District (CAWCD) and approved by Reclamation for any crossings of the canal or dikes in coordination with approved land-use plans, developments, and existing agreements. All crossings or proposed uses of the lands under existing use agreements shall be coordinated with the appropriate land management staffs of Reclamation and the local recreation managing partner.

Environmental Clearances

Pursuant to the National Environmental Policy Act (NEPA) of 1969, as amended, shall conduct an environmental evaluation of any proposal requiring CAWCD approval for use of Federal lands or issuance of a Construction Period Land-Use License. CAWCD will determine the appropriate level of NEPA compliance required and will work with the applicant (or the applicant's contractor, if applicable) in preparing the necessary documentation and implementing a public involvement program, if appropriate. Compliance with NEPA, the Endangered Species Act, the National Historic Preservation Act and other applicable resource-related laws and regulations, as determined by CAWCD, shall be completed prior to any action regarding an applicant's request.

Project Review

In general, projects proposed to affect the canal and dike such as road and pipeline crossings shall be submitted to the CAWCD for review and approval:

Central Arizona Water Conservation District
Lands and Records Division
P.O. Box 43020
Phoenix, Arizona 85080-3020
602-869-2272 or -2265

Project Information Required

Proposals for major construction such as road crossings shall include the following technical studies:

1. Hydrologic and hydraulic analyses demonstrating that the live storage volume of the basins shall be maintained, and that cross flow structures within a basin shall have adequate capacity to allow equalization of water surface elevations during a flood.

2. Slope-stability or seepage analyses or assessments demonstrating that significant changes to dike embankments/foundations shall remain safe for the inflow design flood.

3. Geologic descriptions of areas in the dike detention basin or adjacent to the dike embankments/foundations where significant excavations are planned.

Construction Monitoring

CAWCD will monitor project construction. The CAWCD can withdraw the Construction Period Land-Use License should work deviate from the approved project or if new developments significantly affect the safety and functionality of the project, or the health of the environment.

Hydrologic Dike Safety

Decreasing the total live flood storage capacity of the detention basins is prohibited. If material is imported into a flood detention basin, an equal volume of material shall be removed from that basin, or moved into dead storage in any detention basin, to maintain total live capacity. If the original dike configuration is changed by constructing dike "tails" at road crossings, the excluded live storage volume shall also be compensated for by removal of material from the detention basin, or moved into dead storage in any detention basin.

Movement of materials within a flood detention basin will be allowed subject to approval by the CAWCD based on restrictions given below. However, approval will also be subject to other considerations such as land-use planning and the environment.

Borrowing Material Within Flood Detention Basins

Borrowing materials for construction purposes from within the detention basins may be permitted provided that:

1. Irregular terrain may be leveled to the depth of existing depressions for a radial distance of about 300 feet from the edge of the depression, provided at least 10 percent of the area of the planned excavation would consist of the existing depression, and any edge of the excavation would remain at least 200 feet from the upstream toe of the dike.

2. All excavation activities, including borrow areas, shall be a minimum of 200 feet from the upstream toe of the dike. This is necessary to prevent ponding of water that would direct seepage into the foundation soils of the embankment. The foundation soils are collapsible in many cases.

3. Where terrain is flat, excavations located between 200 and 500 feet upstream of the upstream dike toe are limited to a maximum depth of 5 feet. Excavations located between 500 feet upstream of the upstream dike toe and the right-of-way is limited to a maximum depth of 10 feet.

4. Borrow areas shall be constructed to allow all collected water to drain and flow to the outlet structures, and plans to construct new or alter existing borrow areas will be reviewed on a case-by-case basis.

5. Borrow areas or excavations closer than 500 feet, that penetrate sand and/or gravel lenses shall be covered with an impervious blanket of material a minimum of **2** feet thick, or geo-membranes may be used to form the seal. Consideration may be given to methods other than lining borrow areas to reduce potential water pressure under dikes that might result from impounded flood waters. Leave in place, undisturbed, any pervious layers such as dense caliche or clay, having a surface area of several hundred square feet or more, encountered within 2 feet or less of the planned bottom of excavations.

6. Cut slopes for borrow areas shall not be steeper than 3 feet horizontal to 1 foot vertical.

7. Any materials moved during clearing and grubbing operations within the basins shall be separated, and all unsalvageable vegetation removed to prevent floatation of debris that could obstruct existing drainage or outlet structures.

8. Excavated areas shall be rehabilitated to prevent erosion and to blend with the surrounding environment.

Importing Material into Flood Detention Basins

All materials imported into basins shall be free of deleterious waste or toxic materials, and free of vegetation that could obstruct existing drainage or outlet structures.

Changing Flow Patterns Within Basins

CAWCD shall review proposals for future crossings and land-use development within detention basins. Projects which negatively impact the function and integrity of the dike and detention basins are not acceptable.

Plans for all proposed crossings shall include hydrologic and hydraulic analyses to demonstrate the effects of the crossing upon the function and integrity of the dike and basin. The analyses shall demonstrate that the storage volume of the basins has been maintained and that cross flow structures within a basin have been adequately sized to allow equalization of water surface elevations during a flood event. The design storm for purposes of sizing cross-conveyance structures shall be an event with a percentage of probable maximum flood hydrograph flows that result in volume equal to storage behind the dike at a water

surface elevation 1 foot above the dike design crest elevation. Water surface elevations within the basin on either side of the crossing shall be balanced within 0.1 foot when the water surface behind the dike is 1 foot below the dike design crest elevation. When a basin is divided, a cross-conveyance structure shall be provided to evacuate the part of the basin that is divided from the basin evacuation structure. The invert of this cross-conveyance structure shall be set at or below the dike evacuation structure invert. Recommended minimum capacity of the structure is 750 cubic feet per second with 1 foot head differential and submerged inlet and outlet. This structure does not have to provide the entire cross-conveyance capacity for balancing the inflow flood.

Additionally, historical inflows routed to each detention basin within the Reach 11 dike system shall be maintained (i.e., no rerouting of flows from one drainage basin to another). Flow velocities entering the detention basin shall be kept at or below those of the historical 100-year storm (about 3 feet per second). Any changes in flow patterns upstream shall not result in detrimental effects to the basins as flows outlet into them. Control of erosion and sediment shall be considered when evaluating methods of out-letting run-off into the basins.

Recharge Basins

Recharge basins shall remain 500 or more feet upstream of the upstream dike toe. Irregular terrain may be leveled to the depth of existing depressions for a radial distance of about 300 feet from the edge of the depression, provided at least 10 percent of the area of planned excavation consists of the depression. Where the pre-excavation terrain is flat, the excavation shall not exceed 10 feet deep.

Plan a vertical barrier wall downstream from the recharge basin if pervious sand and/or gravel lenses exposed by the excavations appear to trend toward the foundation of the dike embankments. To deviate from these guidelines, provide technical studies demonstrating the safety of the proposed approach.

Roadway Crossings

The planned work may involve the construction of new roadways through or over the dike embankments. When passing through dikes equipped with a geo-membrane water barrier, plan to attach new geo-membrane panels to the existing barrier at the notched section. Several schemes have been applied already; for example, at the Greenway-Hayden Road Crossing, new vertical panels were attached to the existing vertical barrier at both sides of the roadway notch. The new panels were then extended upstream within a new (realigned) embankment. At the 55th Street crossing, much of the realigned embankment was constructed first, forming a sub grade for a new finer system. The new liner was laid on the sub grade and attached to the existing barrier at the sides and bottom of the notch. Finally, the liner was covered with filter material and earth embankment.

Bridges crossing the canal and basin equalization channels shall be designed in accordance with the requirements of the most recent edition of American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges.

Excavation of the notch and other construction activities may temporarily reduce the detention capacity of the dike embankment. The embankment shall continue to provide flood protection for at least the 500-year storm event through the construction period (not to last more than 6 months).

In excavating the notch, take special care to avoid damaging the existing geo-membrane barrier that shall remain within the existing dike. Mechanical excavation equipment shall not physically contact the geo-membrane.

Cohesive embankment materials in the realigned dike shall be compacted to at least 98 percent of standard laboratory maximum dry density. The compaction water content shall fall within plus or minus 2 percent of optimum water content. Pre-wet the source areas for the cohesive fill by sprinkler irrigation or other effective methods. Ripping the source area using a dozer with ripper tooth, and applying water with a water truck may prove to be an effective method of saturating the source area to the desired depth.

Filter sands (as used in chimney drains or finger drains) and cohesion less embankment materials shall be compacted to a relative density of 70 percent or greater. The filter sand shall meet the requirements of ASTM C-33 concrete sand. The fines content of filter sands shall remain at or below 5 percent by weight of the total sample after placement and compaction. The fines content of cohesion less embankment materials shall exceed 10 percent by weight of the total sample, and the maximum particle size shall not exceed 6 inches.

All stumps and roots larger than 3 inches in diameter shall be cleared and grubbed from the foundation. Loose soil that remains shall be moistened, blended, and compacted in 6-inch lifts (as measured after compaction).

Some of the realigned embankment may be treated as roadway embankment, rather than dike embankment. Roadway embankment in direct contact with dike embankment shall receive the same foundation preparation as the dike embankment, and be compacted to the same degree. Other guidelines stated above need not apply.

Guidelines for Utility Crossings

Plans for any utilities crossing Reach 11 Dikes shall be submitted to the CAWCD for review to assure that the integrity of the dikes is maintained. The submittal shall include, as applicable, a cross-section and profile of the crossing, excavation/boring method for installation, cut slopes, backfill material requirements, geo-membrane sealing methods, and certification of filter material source.

Within the upper 3 feet of the dike, any utility can be installed using open excavation. The excavation shall be no wider than needed to allow adequate backfill compaction. The invert of the utility shall not be more than 3 feet below the crest of the dike. Backfill shall meet the compaction requirements for dike embankment material, 98 percent of Standard Proctor density.

Any utility less than 12 inches in diameter may be bored or installed through the dike using micro-tunneling techniques and is allowed to penetrate the geo-membrane. Jetting installation methods are not allowed. Sealing of the geo-membrane around a utility less than 12 inches in diameter will not be required since it will pass through the 2-foot wide filter zone.

Filter material used in any construction to surround **a** utility through the dike embankment shall be ASTM C-33 concrete sand. Data shall be submitted showing that the sand source is an approved concrete aggregate source meeting ASTM C-33 requirements.

There are additional requirements for utilities crossing or passing through the vertical geo-membrane barrier. Mechanical excavation equipment shall not contact the geo-membrane. If the geo-membrane is present in the upper 3 feet of the dike, the top of the geo-membrane shall be cut only large enough to allow the utility to pass through without damage to the surrounding liner.

For utilities exceeding 12 inches in diameter, the geo-membrane shall be attached to the utility, or the existing filter shall be widened to 4 feet in the area of the utility. In no case will a geo-membrane seal alone be sufficient. This is required because of the more critical nature of this size utility and it's potential to create a preferred erosion pathway for seepage. In one completed project, utilities were encased in concrete, encompassing the geo-membrane liner for a minimum distance of 6 inches in all directions.

CANAL RESTRICTIONS

Maintaining Access

Crossings cannot interfere with maintenance access to the dike slopes or crest.

Crossing Operation and Maintenance (O&M) Roads and the Canal

The CAWCD requires ONE of the following conditions be met to maintain access to the O&M roads at overhead roadway crossings:

1. A minimum clearance of 14.5 feet above the O&M road grade AND a minimum clear roadway width of 24 feet right and 20 feet left of the canal are required. The right and left sides of the canal are designated by facing in the downstream direction of water flow. Roadway width is exclusive of the berm between the O&M road and the canal prism.

2. Ramps connecting the O&M roads with the crossing roadway in all four quadrants of the intersection are required. Appropriate gates and fencing to maintain canal security are necessary. These ramps shall have a minimum roadway-width of 24-feet right, and 20-feet left of the canal. Ramp grade shall not exceed 8 percent, and the external angle between ramp centerline and O&M road centerline is not to exceed 60 degrees.

During construction, one O&M road shall remain open at all times. No shoring or formwork may be placed within the canal prism.