Request for Proposal
RFP-5062-22-SH

COLORADO RIVER LEVEE CONSULTANT SERVICES

RESPONSES DUE:
May 3, 2022 prior to 2:30 P.M.

Accepting Electronic Responses Only Submitted Through the Rocky Mountain E-Purchasing System (RMEPS)
www.bidnetdirect.com/colorado

(Purchasing Representative does not have access or control of the vendor side of RMEPS. If website or other problems arise during response submission, vendor MUST contact RMEPS to resolve issue prior to the response deadline. 800-835-4603)

NOTE: All City solicitation openings will continue to be held virtually. See Section 1.6 for details.

PURCHASING REPRESENTATIVE:
Susan Hyatt, Senior Buyer
susanh@gjcity.org
970-244-1513

This solicitation has been developed specifically for a Request for Proposal intended to solicit competitive responses for this solicitation, and may not be the same as previous City of Grand Junction solicitations. All offerors are urged to thoroughly review this solicitation prior to submitting. Submittal by **FAX, EMAIL or HARD COPY IS NOT ACCEPTABLE** for this solicitation.

REQUEST FOR PROPOSAL

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REQUEST FOR PROPOSAL

SECTION 1.0: ADMINISTRATIVE INFORMATION & CONDITIONS FOR SUBMITTAL

NOTE: It is the Firm's responsibility to read and review all solicitation documentation in its entirety, and to ensure that they have a clear and complete understanding of not only the scope, specifications, project requirements, etc., but also all other requirements, instructions, rules, regulations, laws, conditions, statements, procurement policies, etc. that are associated with the solicitation process and project/services being solicited.

1.1 Issuing Office: This Request for Proposal (RFP) is issued by the City of Grand Junction. All contact regarding this RFP is directed to:

RFP QUESTIONS:
Susan Hyatt, Senior Buyer
susanh@gjcity.org

The City would like to remind all Firms, Sub-Firms, Vendors, Suppliers, Manufacturers, Service Providers, etc. that (with the exception of Pre-Bid or Site Visit Meetings) all questions, inquiries, comments, or communication pertaining to any formal solicitation (whether process, specifications, scope, etc.) must be directed (in writing) to the Purchasing Agent assigned to the project, or Purchasing Division. Direct communication with the City assigned Project Managers/Engineers is not appropriate for public procurement, and may result in disqualification.

1.2 Purpose: The purpose of this RFP is to obtain proposals from qualified engineering firms, licensed in the State of Colorado, to complete the Federal Emergency Management Agency (FEMA) certification process for the Colorado River Levee at Grand Junction to satisfy Title 44 of the Code of Federal Regulations (44 CFR) Section 65.10 requirements.

1.3 The Owner: The Owner is the City of Grand Junction, Colorado (City) and is referred to throughout this Solicitation. The term Owner means the Owner or his authorized representative.

1.4 Compliance: All participating Offerors, by their signature hereunder, shall agree to comply with all conditions, requirements, and instructions of this RFP as stated or implied herein. Should the Owner omit anything from this packet which is necessary to the clear understanding of the requirements, or should it appear that various instructions are in conflict, the Offeror(s) shall secure instructions from the Purchasing Division prior to the date and time of the submittal deadline shown in this RFP.

1.5 Procurement Process: Procurement processes shall be governed by the most current version of the City of Grand Junction Purchasing Policy and Procedure Manual.

1.6 Submission: Each proposal shall be submitted in electronic format only, and only through the Rocky Mountain E-Purchasing (BidNet Colorado) website, www.bidnetdirect.com/colorado**. The uploaded response shall be a single PDF document with all required information included.** *This site offers both "free" and "paying" registration options that allow for full access of the Owner's documents and for electronic submission of proposals. (Note: "free" registration may take up to 24 hours to*

process. Please Plan accordingly.) Please view our "**Electronic Vendor Registration Guide"** at http://www.gjcity.org/501/Purchasing-Bids for details. (Purchasing Representative does not have access or control of the vendor side of RMEPS. If website or other problems arise during response submission, vendor **MUST** contact RMEPS to resolve issue prior to the response deadline. **800-835-4603**).

Please join the virtual opening for Colorado River Levee Consultant Services on May 3, 2022 at 2:30 P.M.

Please join the meeting from your computer, tablet or smartphone.
https://meet.goto.com/630667453

You can also dial in using your phone.
United States: +1 (646) 749-3122

Access Code: 630-667-453

Join from a video-conferencing room or system.
Dial in or type: 67.217.95.2 or inroomlink.goto.com
Meeting ID: 630 667 453
Or dial directly: 630667453@67.217.95.2 or 67.217.95.2##630667453

1.7 Altering Proposals: Any alterations made prior to opening date and time must be initialed by the signer of the proposal, guaranteeing authenticity. Proposals cannot be altered or amended after submission deadline.

1.8 Withdrawal of Proposal: A proposal must be firm and valid for award and may not be withdrawn or canceled by the Offeror for sixty (60) days following the submittal deadline date, and only prior to award. The Offeror so agrees upon submittal of their proposal. After award this statement is not applicable.

1.9 Acceptance of Proposal Content: The contents of the proposal of the successful Offeror shall become contractual obligations if acquisition action ensues. Failure of the successful Offeror to accept these obligations in a contract shall result in cancellation of the award and such vendor shall be removed from future solicitations.

1.10 Addenda: All questions shall be submitted in writing to the appropriate person as shown in Section 1.1. Any interpretations, corrections and changes to this RFP or extensions to the opening/receipt date shall be made by a written Addendum to the RFP by the City. Sole authority to authorize addenda shall be vested in the City of Grand Junction Purchasing Representative. Addenda will be issued electronically through the Rocky Mountain E-Purchasing website at www.bidnetdirect.com/colorado and on the City's website at www.gjcity.org/501/Purchasing/Bids . Offerors shall acknowledge receipt of all addenda in their proposal.

1.11 Exceptions and Substitutions: All proposals meeting the intent of this RFP shall be considered for award. Offerors taking exception to the specifications shall do so at their own risk. The Owner reserves the right to accept or reject any or all substitutions or alternatives. When offering substitutions and/or alternatives, Offeror must state these exceptions in the section pertaining to that area. Exception/substitution, if accepted, must meet or exceed the stated intent and/or specifications. The absence of such a list shall

indicate that the Offeror has not taken exceptions, and if awarded a contract, shall hold the Offeror responsible to perform in strict accordance with the specifications or scope of services contained herein.

1.12 Confidential Material: All materials submitted in response to this RFP shall ultimately become public record and shall be subject to inspection after contract award. "**Proprietary or Confidential Information"** is defined as any information that is not generally known to competitors and which provides a competitive advantage. Unrestricted disclosure of proprietary information places it in the public domain. Only submittal information clearly identified with the words "***Confidential Disclosure***" and uploaded as a separate document shall establish a confidential, proprietary relationship. Any material to be treated as confidential or proprietary in nature must include a justification for the request. The request shall be reviewed and either approved or denied by the Owner. If denied, the proposer shall have the opportunity to withdraw its entire proposal, or to remove the confidential or proprietary restrictions. Neither cost nor pricing information nor the total proposal shall be considered confidential or proprietary.

1.13 Response Material Ownership: All proposals become the property of the Owner upon receipt and shall only be returned to the proposer at the Owner's option. Selection or rejection of the proposal shall not affect this right. The Owner shall have the right to use all ideas or adaptations of the ideas contained in any proposal received in response to this RFP, subject to limitations outlined in the entitled "Confidential Material". Disqualification of a proposal does not eliminate this right.

1.14 Minimal Standards for Responsible Prospective Offerors: A prospective Offeror must affirmably demonstrate their responsibility. A prospective Offeror must meet the following requirements.

- Have adequate financial resources, or the ability to obtain such resources as required.
- Be able to comply with the required or proposed completion schedule.
- Have a satisfactory record of performance.
- Have a satisfactory record of integrity and ethics.
- Be otherwise qualified and eligible to receive an award and enter into a contract with the Owner.

1.15 Open Records: Proposals shall be received and publicly acknowledged at the location, date, and time stated herein. Offerors, their representatives and interested persons may be present. Proposals shall be received and acknowledged only so as to avoid disclosure of process. However, all proposals shall be open for public inspection after the contract is awarded. Trade secrets and confidential information contained in the proposal so identified by offer as such shall be treated as confidential by the Owner to the extent allowable in the Open Records Act.

1.16 Sales Tax: The Owner is, by statute, exempt from the State Sales Tax and Federal Excise Tax; therefore, all fees shall not include taxes.

1.17 Public Opening: Proposals shall be opened virtually immediately following the proposal deadline. Offerors, their representatives and interested persons may attend virtually. See Section 1.6 for details. Only the names and locations on the proposing firms will be disclosed.

SECTION 2.0: GENERAL CONTRACT TERMS AND CONDITIONS

2.1. Acceptance of RFP Terms: A proposal submitted in response to this RFP shall constitute a binding offer. Acknowledgment of this condition shall be indicated on the Letter of Interest or Cover Letter by the autographic signature of the Offeror or an officer of the Offeror legally authorized to execute contractual obligations. A submission in response to the RFP acknowledges acceptance by the Offeror of all terms and conditions including compensation, as set forth herein. An Offeror shall identify clearly and thoroughly any variations between its proposal and the Owner's RFP requirements. Failure to do so shall be deemed a waiver of any rights to subsequently modify the terms of performance, except as outlined or specified in the RFP.

2.2. Execution, Correlation, Intent, and Interpretations: The Contract Documents shall be signed by the Owner and Firm. By executing the contract, the Firm represents that they have familiarized themselves with the local conditions under which the Services is to be performed, and correlated their observations with the requirements of the Contract Documents. The Contract Documents are complementary, and what is required by any one, shall be as binding as if required by all. The intention of the documents is to include all labor, materials, equipment, services and other items necessary for the proper execution and completion of the scope of services as defined in the technical specifications and drawings contained herein. All drawings, specifications and copies furnished by the Owner are, and shall remain, Owner property. They are not to be used on any other project.

2.3. Permits, Fees, & Notices: The Firm shall secure and pay for all permits, governmental fees and licenses necessary for the proper execution and completion of the services. The Firm shall give all notices and comply with all laws, ordinances, rules, regulations and orders of any public authority bearing on the performance of the services. If the Firm observes that any of the Contract Documents are at variance in any respect, he shall promptly notify the Owner in writing, and any necessary changes shall be adjusted by approximate modification. If the Firm performs any services knowing it to be contrary to such laws, ordinances, rules and regulations, and without such notice to the Owner, he shall assume full responsibility and shall bear all costs attributable.

2.4. Responsibility for those Performing the Services: The Firm shall be responsible to the Owner for the acts and omissions of all his employees and all other persons performing any of the services under a contract with the Firm.

2.5. Payment & Completion: The Contract Sum is stated in the Contract and is the total amount payable by the Owner to the Firm for the performance of the services under the Contract Documents. Upon receipt of written notice that the services is ready for final inspection and acceptance and upon receipt of application for payment, the Owner's Project Manager will promptly make such inspection and, when they find the services acceptable under the Contract Documents and the Contract fully performed, the Owner shall make payment in the manner provided in the Contract Documents. Partial payments will be based upon estimates, prepared by the Firm, of the value of services performed and materials placed in accordance with the Contract Documents. The services performed by Firm shall be in accordance with generally accepted professional practices and the level of competency presently maintained by other practicing professional firms in the same or similar type of services in the applicable community. The services and services to be performed by

Firm hereunder shall be done in compliance with applicable laws, ordinances, rules and regulations.

2.6. Protection of Persons & Property: The Firm shall comply with all applicable laws, ordinances, rules, regulations and orders of any public authority having jurisdiction for the safety of persons or property or to protect them from damage, injury or loss. Firm shall erect and maintain, as required by existing safeguards for safety and protection, and all reasonable precautions, including posting danger signs or other warnings against hazards promulgating safety regulations and notifying owners and users of adjacent utilities. When or where any direct or indirect damage or injury is done to public or private property by or on account of any act, omission, neglect, or misconduct by the Firm in the execution of the services, or in consequence of the non-execution thereof by the Firm, they shall restore, at their own expense, such property to a condition similar or equal to that existing before such damage or injury was done, by repairing, rebuilding, or otherwise restoring as may be directed, or it shall make good such damage or injury in an acceptable manner.

2.7. Changes in the Services: The Owner, without invalidating the contract, may order changes in the services within the general scope of the contract consisting of additions, deletions or other revisions. All such changes in the services shall be authorized by Change Order/Amendment and shall be executed under the applicable conditions of the contract documents. A Change Order/Amendment is a written order to the Firm signed by the Owner issued after the execution of the contract, authorizing a change in the services or an adjustment in the contract sum or the contract time.

2.8. Minor Changes in the Services: The Owner shall have authority to order minor changes in the services not involving an adjustment in the contract sum or an extension of the contract time and not inconsistent with the intent of the contract documents.

2.9. Uncovering & Correction of Services: The Firm shall promptly correct all services found by the Owner as defective or as failing to conform to the contract documents. The Firm shall bear all costs of correcting such rejected services, including the cost of the Owner's additional services thereby made necessary. The Owner shall give such notice promptly after discover of condition. All such defective or non-conforming services under the above paragraphs shall be removed from the site where necessary and the services shall be corrected to comply with the contract documents without cost to the Owner.

2.10. Acceptance Not Waiver: The Owner's acceptance or approval of any services furnished hereunder shall not in any way relieve the proposer of their present responsibility to maintain the high quality, integrity and timeliness of his services. The Owner's approval or acceptance of, or payment for, any services shall not be construed as a future waiver of any rights under this Contract, or of any cause of action arising out of performance under this Contract.

2.11. Change Order/Amendment: No oral statement of any person shall modify or otherwise change, or affect the terms, conditions or specifications stated in the resulting contract. All amendments to the contract shall be made in writing by the Owner.

2.12. Assignment: The Offeror shall not sell, assign, transfer or convey any contract resulting from this RFP, in whole or in part, without the prior written approval from the Owner.

2.13. Compliance with Laws: Proposals must comply with all Federal, State, County and local laws governing or covering this type of service and the fulfillment of all ADA (Americans with Disabilities Act) requirements. Firm hereby warrants that it is qualified to assume the responsibilities and render the services described herein and has all requisite corporate authority and professional licenses in good standing, required by law.

2.14. Debarment/Suspension: The Firm herby certifies that the Firm is not presently debarred, suspended, proposed for debarment, declared ineligible, or voluntarily excluded from covered transactions by any Governmental department or agency.

2.15. Confidentiality: All information disclosed by the Owner to the Offeror for the purpose of the services to be done or information that comes to the attention of the Offeror during the course of performing such services is to be kept strictly confidential.

2.16. Conflict of Interest: No public official and/or Owner employee shall have interest in any contract resulting from this RFP.

2.17. Contract: This Request for Proposal, submitted documents, and any negotiations, when properly accepted by the Owner, shall constitute a contract equally binding between the Owner and Offeror. The contract represents the entire and integrated agreement between the parties hereto and supersedes all prior negotiations, representations, or agreements, either written or oral, including the Proposal documents. The contract may be amended or modified with Change Orders, Field Orders, or Amendment.

2.18. Project Manager/Administrator: The Project Manager, on behalf of the Owner, shall render decisions in a timely manner pertaining to the services proposed or performed by the Offeror. The Project Manager shall be responsible for approval and/or acceptance of any related performance of the Scope of Services.

2.19. Contract Termination: This contract shall remain in effect until any of the following occurs: (1) contract expires; (2) completion of services; (3) acceptance of services or, (4) for convenience terminated by either party with a written *Notice of Cancellation* stating therein the reasons for such cancellation and the effective date of cancellation at least thirty days past notification.

2.20. Employment Discrimination: During the performance of any services per agreement with the Owner, the Offeror, by submitting a Proposal, agrees to the following conditions:

2.20.1. The Offeror shall not discriminate against any employee or applicant for employment because of race, religion, color, sex, age, disability, citizenship status, marital status, veteran status, sexual orientation, national origin, or any legally protected status except when such condition is a legitimate occupational qualification reasonably necessary for the normal operations of the Offeror. The Offeror agrees to post in conspicuous places, visible to employees and applicants for employment, notices setting forth the provisions of this nondiscrimination clause.

2.20.2. The Offeror, in all solicitations or advertisements for employees placed by or on behalf of the Offeror, shall state that such Offeror is an Equal Opportunity Employer.

2.20.3. Notices, advertisements, and solicitations placed in accordance with federal law, rule, or regulation shall be deemed sufficient for the purpose of meeting the requirements of this section.

2.21. Immigration Reform and Control Act of 1986 and Immigration Compliance: The Offeror certifies that it does not and will not during the performance of the contract employ illegal alien services or otherwise violate the provisions of the Federal Immigration Reform and Control Act of 1986 and/or the immigration compliance requirements of State of Colorado C.R.S. § 8-17.5-101, *et.seq.* (House Bill 06-1343).

2.22. Ethics: The Offeror shall not accept or offer gifts or anything of value nor enter into any business arrangement with any employee, official, or agent of the Owner.

2.23. Failure to Deliver: In the event of failure of the Offeror to deliver services in accordance with the contract terms and conditions, the Owner, after due oral or written notice, may procure the services from other sources and hold the Offeror responsible for any costs resulting in additional purchase and administrative services. This remedy shall be in addition to any other remedies that the Owner may have.

2.24. Failure to Enforce: Failure by the Owner at any time to enforce the provisions of the contract shall not be construed as a waiver of any such provisions. Such failure to enforce shall not affect the validity of the contract or any part thereof or the right of the Owner to enforce any provision at any time in accordance with its terms.

2.25. Force Majeure: The Offeror shall not be held responsible for failure to perform the duties and responsibilities imposed by the contract due to legal strikes, fires, riots, rebellions, and acts of God beyond the control of the Offeror, unless otherwise specified in the contract.

2.26. Indemnification: Offeror shall defend, indemnify and save harmless the Owner and all its officers, employees, insurers, and self-insurance pool, from and against all liability, suits, actions, or other claims of any character, name and description brought for or on account of any injuries or damages received or sustained by any person, persons, or property on account of any negligent act or fault of the Offeror, or of any Offeror's agent, employee, sub-Firm or supplier in the execution of, or performance under, any contract which may result from proposal award. Offeror shall pay any judgment with cost which may be obtained against the Owner growing out of such injury or damages.

2.27. Independent Firm: The Offeror shall be legally considered an Independent Firm and neither the Firm nor its employees shall, under any circumstances, be considered servants or agents of the Owner. The Owner shall be at no time legally responsible for any negligence or other wrongdoing by the Firm, its servants, or agents. The Owner shall not withhold from the contract payments to the Firm any federal or state unemployment taxes, federal or state income taxes, Social Security Tax or any other amounts for benefits to the Firm. Further, the Owner shall not provide to the Firm any insurance coverage or other benefits, including Workers' Compensation, normally provided by the Owner for its employees.

2.28. Nonconforming Terms and Conditions: A proposal that includes terms and conditions that do not conform to the terms and conditions of this Request for Proposal is subject to rejection as non-responsive. The Owner reserves the right to permit the Offeror to withdraw

nonconforming terms and conditions from its proposal prior to a determination by the Owner of non-responsiveness based on the submission of nonconforming terms and conditions.

2.29. Ownership: All plans, prints, designs, concepts, etc., shall become the property of the Owner.

2.30. Oral Statements: No oral statement of any person shall modify or otherwise affect the terms, conditions, or specifications stated in this document and/or resulting agreement. All modifications to this request and any agreement must be made in writing by the Owner.

2.31. Patents/Copyrights: The Offeror agrees to protect the Owner from any claims involving infringements of patents and/or copyrights. In no event shall the Owner be liable to the Offeror for any/all suits arising on the grounds of patent(s)/copyright(s) infringement. Patent/copyright infringement shall null and void any agreement resulting from response to this RFP.

2.32. Venue: Any agreement as a result of responding to this RFP shall be deemed to have been made in, and shall be construed and interpreted in accordance with, the laws of the City of Grand Junction, Mesa County, Colorado.

2.33. Expenses: Expenses incurred in preparation, submission and presentation of this RFP are the responsibility of the company and cannot be charged to the Owner.

2.34. Sovereign Immunity: The Owner specifically reserves its right to sovereign immunity pursuant to Colorado State Law as a defense to any action arising in conjunction to this agreement.

2.35. Public Funds/Non-Appropriation of Funds: Funds for payment have been provided through the Owner's budget approved by the City Council/Board of County Commissioners for the stated fiscal year only. State of Colorado statutes prohibit the obligation and expenditure of public funds beyond the fiscal year for which a budget has been approved. Therefore, anticipated orders or other obligations that may arise past the end of the stated Owner's fiscal year shall be subject to budget approval. Any contract will be subject to and must contain a governmental non-appropriation of funds clause.

2.36. Collusion Clause: Each Offeror by submitting a proposal certifies that it is not party to any collusive action or any action that may be in violation of the Sherman Antitrust Act. Any and all proposals shall be rejected if there is evidence or reason for believing that collusion exists among the proposers. The Owner may or may not, at the discretion of the Owner Purchasing Representative, accept future proposals for the same service or commodities for participants in such collusion.

2.37. Gratuities: The Firm certifies and agrees that no gratuities or kickbacks were paid in connection with this contract, nor were any fees, commissions, gifts or other considerations made contingent upon the award of this contract. If the Firm breaches or violates this warranty, the Owner may, at their discretion, terminate this contract without liability to the Owner.

2.38. Performance of the Contract: The Owner reserves the right to enforce the performance of the contract in any manner prescribed by law or deemed to be in the best interest of the Owner in the event of breach or default of resulting contract award.

2.39. Benefit Claims: The Owner shall not provide to the Offeror any insurance coverage or other benefits, including Worker's Compensation, normally provided by the Owner for its employees.

2.40. Default: The Owner reserves the right to terminate the contract in the event the Firm fails to meet delivery or completion schedules, or otherwise perform in accordance with the accepted proposal. Breach of contract or default authorizes the Owner to purchase like services elsewhere and charge the full increase in cost to the defaulting Offeror.

2.41. Multiple Offers: If said proposer chooses to submit more than one offer, THE ALTERNATE OFFER must be clearly marked "Alternate Proposal". The Owner reserves the right to make award in the best interest of the Owner.

2.42. Cooperative Purchasing: Purchases as a result of this solicitation are primarily for the Owner. Other governmental entities may be extended the opportunity to utilize the resultant contract award with the agreement of the successful provider and the participating agencies. All participating entities will be required to abide by the specifications, terms, conditions and pricings established in this Proposal. The quantities furnished in this proposal document are for only the Owner. It does not include quantities for any other jurisdiction. The Owner will be responsible only for the award for our jurisdiction. Other participating entities will place their own awards on their respective Purchase Orders through their purchasing office or use their purchasing card for purchase/payment as authorized or agreed upon between the provider and the individual entity. The Owner accepts no liability for payment of orders placed by other participating jurisdictions that choose to piggy-back on our solicitation. Orders placed by participating jurisdictions under the terms of this solicitation will indicate their specific delivery and invoicing instructions.

2.43. Definitions:

2.43.1. "Offeror" and/or "Proposer" refers to the person or persons legally authorized by the Consultant to make an offer and/or submit a response (fee) proposal in response to the Owner's RFP.

2.43.2. The term "Services" includes all labor, materials, equipment, and/or services necessary to produce the requirements of the Contract Documents.

2.43.3. "Firm" is the person, organization, firm or consultant identified as such in the Agreement and is referred to throughout the Contract Documents. The term Firm means the Firm or his authorized representative. The Firm shall carefully study and compare the Scope of Services, Addenda and Modifications and shall at once report to the Owner any error, inconsistency or omission he may discover. Firm shall not be liable to the Owner for any damage resulting from such errors, inconsistencies or omissions. The Firm shall not commence services without clarifying Drawings, Specifications, or Interpretations.

2.43.4. "Sub-Contractor is a person or organization who has a direct contract with the Firm to perform any of the services at the site. The term Sub-Firm is referred to throughout the contract documents and means a Sub-Contractor or his authorized representative.

2.44. Public Disclosure Record: If the Proposer has knowledge of their employee(s) or sub-proposers having an immediate family relationship with an Owner employee or elected official, the proposer must provide the Purchasing Representative with the name(s) of these individuals. These individuals are required to file an acceptable "Public Disclosure Record", a statement of financial interest, before conducting business with the Owner.

SECTION 3.0: INSURANCE REQUIREMENTS

3.1 Insurance Requirements: The selected Firm agrees to procure and maintain, at its own cost, policy(s) of insurance sufficient to insure against all liability, claims, demands, and other obligations assumed by the Firm pursuant to this Section. Such insurance shall be in addition to any other insurance requirements imposed by this Contract or by law. The Firm shall not be relieved of any liability, claims, demands, or other obligations assumed pursuant to this Section by reason of its failure to procure or maintain insurance in sufficient amounts, durations, or types.

Firm shall procure and maintain and, if applicable, shall cause any Sub-Firm of the Firm to procure and maintain insurance coverage listed below. Such coverage shall be procured and maintained with forms and insurers acceptable to The Owner. All coverage shall be continuously maintained to cover all liability, claims, demands, and other obligations assumed by the Firm pursuant to this Section. In the case of any claims-made policy, the necessary retroactive dates and extended reporting periods shall be procured to maintain such continuous coverage. Minimum coverage limits shall be as indicated below unless specified otherwise in the Special Conditions:

(a) Worker Compensation: Firm shall comply with all State of Colorado Regulations concerning Workers' Compensation insurance coverage.

(b) General Liability insurance with minimum combined single limits of:

ONE MILLION DOLLARS ($1,000,000) each occurrence and
ONE MILLION DOLLARS ($1,000,000) per job aggregate.

The policy shall be applicable to all premises, products and completed operations. The policy shall include coverage for bodily injury, broad form property damage (including completed operations), personal injury (including coverage for contractual and employee acts), blanket contractual, products, and completed operations. The policy shall include coverage for explosion, collapse, and underground (XCU) hazards. The policy shall contain a severability of interests provision.

(c) Comprehensive Automobile Liability insurance with minimum combined single limits for bodily injury and property damage of not less than:

ONE MILLION DOLLARS ($1,000,000) each occurrence and
ONE MILLION DOLLARS ($1,000,000) aggregate

(d) Professional Liability & Errors and Omissions Insurance policy with a minimum of:

ONE MILLION DOLLARS ($1,000,000) per claim

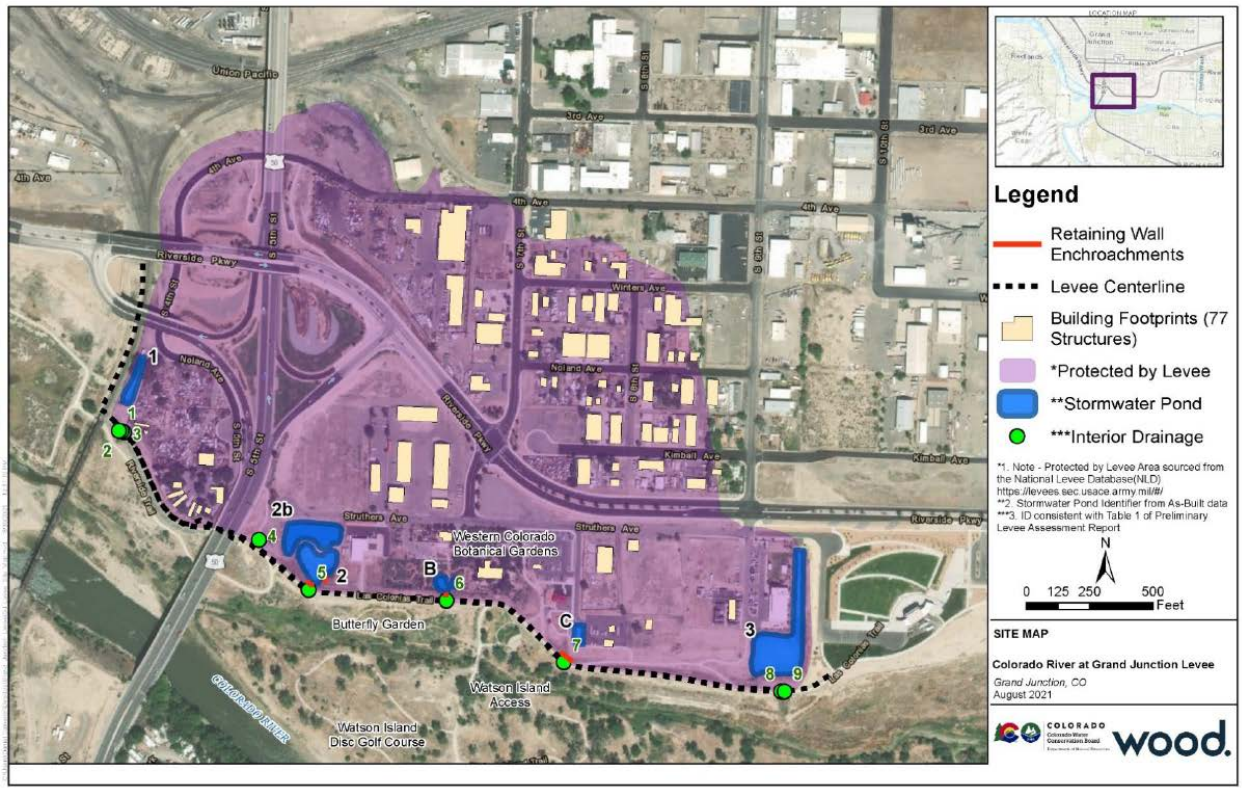
This policy shall provide coverage to protect the Firm against liability incurred as a result of the professional services performed as a result of responding to this Solicitation.

With respect to each of Consultant's owned, hired, or non-owned vehicles assigned to be used in performance of the Services. The policy shall contain a severability of interests provision.

3.2 Additional Insured Endorsement: The policies required by paragraphs (b), and (c) above shall be endorsed to include the Owner and the Owner's officers and employees as additional insureds. Every policy required above shall be primary insurance, and any insurance carried by the Owner, its officers, or its employees, or carried by or provided through any insurance pool of the Owner, shall be excess and not contributory insurance to that provided by Firm. The Firm shall be solely responsible for any deductible losses under any policy required above.

SECTION 4.0: SPECIFICATIONS/SCOPE OF SERVICES

4.1. General/Background: The Colorado River Levee at Grand Junction ("the levee") is an earthen embankment constructed in 1997 to reduce the flood risk from Colorado River during major storm events. It extends approximately 0.7 miles along the Las Colonias Trail, north of the Colorado River, from the Las Colonias Amphitheater westward to the Union Pacific Railroad. To support interior drainage there are several outlet structures located along the levee. In addition to flood protection, the levee provides a recreation component with a concrete sidewalk along the levee crest.



Source: Preliminary Levee Assessment Report, October 2021

For the levee to be recognized by the FEMA and depicted on the upcoming countywide Flood Insurance Rate Map update, evidence that adequate design, operation, and maintenance systems are in place to protect from base flood elevations must be provided. Lack of accreditation will result in areas, currently mapped as Zone X (Protected by Levee), being designated as Special Flood Hazard Areas (SFHA), followed by mandatory flood insurance requirements and increased development standards.

The specific requirements for accreditation are outlined in Title 44 of the Code of Federal Regulations (44 CFR) 65.10.

In October of 2021, a Preliminary Levee Assessment Report was completed for the Grand Junction Levee, in partnership with the Colorado Water Conservation Board, to evaluate the existing levee condition and provide direction on additional data collection and analyses where deficiencies exist to satisfy the 44 CFR 65.10 requirements.

4.2. Price/Fees: Project pricing shall be all inclusive, to include, but not be limited to: labor, materials, equipment, travel, design, drawings, engineering work, shipping/freight, licenses, permits, fees, etc.

The Owner shall not pay nor be liable for any other additional costs including but not limited to: taxes, shipping charges, insurance, interest, penalties, termination payments, attorney fees, liquidated damages, etc.

Provide a not to exceed cost using Solicitation Response Form found in Section 7, accompanied by a complete list of costs breakdown and rates sheets.

All fees will be considered by the Owner to be negotiable.

4.3. Specifications/Scope of Services:

4.3.1. Project Goals: The City of Grand Junction is seeking proposals from engineering firms, licensed in the State of Colorado, to complete the FEMA certification process for the Colorado River Levee at Grand Junction to satisfy Title 44 of the Code of Federal Regulations Section 65.10 requirements.

The scope should include identification of the levee system segments that meet certification criteria, certification of those portions, and identification of the parts of the levee system that are deficient. Recommendations for modifications to obtain certification to FEMA requirements will be a key component of the project.

Project Scope of Work will include:

1. Project Management – The Consultant will coordinate all tasks with City of Grand Junction Project Manager, develop and maintain a project schedule, manage subconsultants, lead project meetings, provide status updates, develop meeting minutes, and submit monthly invoices
2. Coordination – with key project stakeholders, including United States Army Corps of Engineers (USACE), FEMA, and adjacent property owners
3. Geotechnical Analysis – in accordance with the USACE 'Drilling in Earth Embankment Dams and Levees' requirements, to document the levee embankment, stability, and settlement conditions
4. Hydraulic Analysis – to evaluate geomorphology, scour potential, and internal drainage conditions
5. Reporting & Documentation – certified by a professional engineer to support Section 65.10 Design Criteria, Interior Drainage Analysis, and Operation and Maintenance requirements
6. Design – capital improvements where the levee is not in compliance with Section 65.10 requirements

To support the project components above the following tasks are anticipated:

- Prior to the initiation of field work the Consultant shall obtain, and pay for, all permits necessary to perform site survey and geotechnical explorations
- The Consultant will be responsible for locating and coordinating with all utilities, as required to locate all utilities in the vicinity of the exploration area.
- Perform levee survey control development to support freeboard analysis and As-built document preparation.
- This work may include aerial mapping and GIS mapping.

- The Consultant shall prepare all necessary design plans, drawings and specifications to be used for the construction of the improvements and should therefore be complete in detail and contain all necessary information. Anticipated design plans include:
  - Freeboard deficiencies, upstream of the railroad crossing
  - Interior drainage infrastructure improvements, outlined on Table 1 of the 2021 Preliminary Levee Assessment Report
  - Vegetation & Encroachment removals in accordance with Section 65.10 Design Criteria
- Operation Plan Updates:
  - Review of Flood Warning system documentation and updated operation information that will be provided by the City.
  - The Consultant shall update or prepare an addendum to the USACE Operations & Maintenance (O&M) Manual as necessary to satisfy the requirements contained within Title 44 of the Code of Federal Regulations; 44 CFR 65.10.
- Final Certified As-Built Plans, that reflect post-project conditions
- Subsequent construction oversight and inspection may be additional outcomes of the project.

4.3.2 Additional Information

- A copy of the Preliminary Levee Assessment Report completed in 2021 for the Colorado Water Conservation Board is attached in Appendix A.

- A copy of the Base Level Engineering Report Mesa County, CO – Wood, 2019 is attached in Appendix B.

- A copy of the current USACE O&M Manual is attached as Appendix C.

- CO River Levee at Grand Junction, CO – As Builts, 1997 (Appendix D)

- Drilling in Earth Embankment Dams and Levees – USACE, 2014: https://www.publications.usace.army.mil/portals/76/publications/engineerregulations/er_1110-1-1807.pdf

- USACE National Levee Database: https://levees.sec.usace.army.mil/#/levees/system/5205030081/summary

4.4. Project Manager: The Project Manager for this Project is Lisa Froshaug. After contract award, all notices, letters, submittals, and other communications directed to the City shall be addressed and mailed or delivered to:

City of Grand Junction
Public Works Department – Engineering
Attn: Lisa Froshaug, Project Engineer
333 West Avenue, Bldg C
Grand Junction, CO 81501
970-244-1592
lisafr@gjcity.org

4.5. Contract Administrator: The Contract Administrator for this Project is Duane Hoff. After award, all contract related inquiries, issues, and other communications shall be directed to:

City of Grand Junction
General Services Department – Purchasing
Attn: Duane Hoff, Jr.
910 Main Street
Grand Junction, CO 81501
duaneh@gjcity.org

4.6. Timeline: It is expected that all analysis, design, and reports for certification will be completed December 1st, 2022. It is understood that this contract may be extended to include documentation for certification of any physical improvements not completed by the completion date.

4.7. Implementation/Final Report: The implementation of this project will be determined by the consultant whose timeline will be used as one of the evaluation criteria. Please provide a good faith estimate of when the final report can be delivered.

4.8. RFP Tentative Time Schedule:

- Request for Proposal available: April 12, 2022
- Inquiry deadline, no questions after this date: April 21, 2022
- Addendum Posted: April 26, 2022
- Submittal deadline for proposals: May 3, 2022
- Owner evaluation of proposals: May 6, 2022
- Interviews (if required) May 12-13, 2022
- Final selection: May 20, 2022
- Contract execution: May 25, 2022
- Complete by December 1, 2022

4.9. Questions Regarding Scope of Services:

Susan Hyatt., Senior Buyer
susanh@gjcity.org

4.10 Term of Contract: The term of the contract shall be for one year, with the option to renew up to three (3) additional one year periods if needed, based on satisfactory performance of the contractor and mutual agreement with the City.

SECTION 5.0: PREPARATION AND SUBMITTAL OF PROPOSALS

Submission: **Each proposal shall be submitted in electronic format only through the BidNet website, www.bidnetdirect.com/colorado.** This site offers both "free" and "paying" registration options that allow for full access of the City's documents and for electronic submission of proposals. (Note: "free" registration may take up to 24 hours to process. Please Plan accordingly.) (Purchasing Representative does not have access or control of the vendor side of RMEPS. If website or other problems arise during response submission, vendor **MUST** contact RMEPS to resolve issue prior to the response deadline; **800-835-4603**). For proper comparison and evaluation, the City requests that proposals be formatted as directed. **The uploaded response to this RFP shall be a single PDF document with all required information included.** Offerors are required to indicate their interest in this Project, show their specific experience and address their capability to perform the Scope of Services in the Time Schedule as set forth herein. For proper comparison and evaluation, the City requires that proposals be formatted **A** to **F**.

A. **Cover Letter:** Cover letter shall be provided which explains the Firm's interest in the project. The letter shall contain the name/address/phone number/email of the person who will serve as the firm's principal contact person with City's Contract Administrator and shall identify individual(s) who will be authorized to make presentations on behalf of the firm. The statement shall bear the signature of the person having proper authority to make formal commitments on behalf of the firm. By submitting a response to this solicitation, the Firm agrees to all requirements herein.

B. **Qualifications/Experience/Credentials:** Proposers shall provide statement of qualifications indicating the firm's qualifications, experience with similar work, technical expertise, capability to perform the work, familiarity with the project area, and resumes.

C. **Strategy and Implementation:** Describe your (the firm's) interpretation of the Owner's objectives with regard to this RFP. Describe the proposed strategy and/or plan for achieving the objectives of this RFP. The Firm may utilize a written narrative or any other printed technique to demonstrate their ability to satisfy the Scope of Services. The narrative should describe a logical progression of tasks and efforts starting with the initial steps or tasks to be accomplished and continuing until all proposed tasks are fully described and the RFP objectives are accomplished. Include a **time schedule** for completion of your firm's implementation plan and an estimate of time commitments from Owner staff.

D. **References:** A minimum of three (3) **references** that can attest to your experience in projects of similar scope and size. **Please also summarize the projects completed with these references including** Client Name, Address, Contact Person, Telephone, Email Address, Project Dates, Project Description, etc.

E. **Fee Proposal:** Provide an all-inclusive, not to exceed cost using Solicitation Response Form found in Section 7.0, accompanied by a complete list of costs breakdown (**NOTE**: There is a section for optional pricing if virtual meetings are held in lieu of personal or onsite meetings).

F. **Additional Data (optional):** Provide any additional information that will aid in evaluation of your qualifications with respect to this project.

SECTION 6.0: EVALUATION CRITERIA AND FACTORS

6.1 Evaluation: An evaluation team shall review all responses and select the proposal or proposals that best demonstrate the capability in all aspects to perform the scope of services and possess the integrity and reliability that will ensure good faith performance.

6.2 Intent: Only respondents who meet the qualification criteria will be considered. Therefore, it is imperative that the submitted proposal clearly indicate the firm's ability to provide the services described herein.

Submittal evaluations will be done in accordance with the criteria and procedure defined herein. The Owner reserves the right to reject any and all portions of proposals and take into consideration past performance. The following parameters will be used to evaluate the submittals (**with weighted values**):

The following collective criteria shall be worth 90%
• Responsiveness of Submittal to the RFP **(10)** (Firm has submitted a proposal that is fully comprehensive, inclusive, and conforms in all respects to the Request for Proposals (RFP) and all of its requirements, including all forms and substance.) • Experience **(30)** (Firm's proven proficiency in the successful completion of similar projects.) • Understanding Project & Objectives **(20)** (Firm's ability to demonstrate a thorough understanding of the City's goals pertaining to this specific project.) • Strategy & Implementation Plan **(30)** (Firm has provided a clear interpretation of the City's objectives in regard to the project, and a fully comprehensive plan to achieve successful completion. See Section 5.0 Item C for details. Timeline of final report included in this score.)

The following criteria shall be worth 10%
* Fees **(10)**

Owner also reserves the right to take into consideration past performance of previous awards/contracts with the Owner of any vendor, firm, supplier, or service provider in determining final award(s).

References of the short-listed firms will be assessed during the final phase of the evaluation process.

The Owner will undertake negotiations with the top-rated firm and will not negotiate with lower rated firms unless negotiations with higher rated firms have been unsuccessful and terminated.

6.3 Oral Interviews: The Owner reserves the right to invite the most qualified rated proposer(s) to participate in oral interviews, if needed.

6.4 Award: Firms shall be ranked or disqualified based on the criteria listed in Section 6.2. The Owner reserves the right to consider all of the information submitted and/or oral presentations, if required, in selecting the project Firm.

SECTION 7.0: SOLICITATION RESPONSE FORM

RFP-5062-22-SH Colorado River Levee Consultant Services

*Offeror must submit entire Form completed, dated and signed***.**

All inclusive, not to exceed cost to provide Colorado River Levee Consultant Services:

$_____

Total Amount Written: _____**Dollars**

Anticipated completion date: _____

The City of Grand Junction reserves the right to accept any portion of described services to be performed at its discretion

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The undersigned has thoroughly examined the entire Request for Proposals and therefore submits the proposal and schedule of fees and services attached hereto.

This offer is firm and irrevocable for sixty (60) days after the time and date set for receipt of proposals.

The undersigned Offeror agrees to provide services and products in accordance with the terms and conditions contained in this Request for Proposal and as described in the Offeror's proposal attached hereto; as accepted by the Owner.

Prices in the proposal have not knowingly been disclosed with another provider and will not be prior to award.

- Prices in this proposal have been arrived at independently, without consultation, communication or agreement for the purpose of restricting competition.
- No attempt has been made nor will be to induce any other person or firm to submit a proposal for the purpose of restricting competition.
- The individual signing this proposal certifies they are a legal agent of the offeror, authorized to represent the offeror and is legally responsible for the offer with regard to supporting documentation and prices provided.
- Direct purchases by the City of Grand Junction are tax exempt from Colorado Sales or Use Tax. Tax exempt No. 98-903544. The undersigned certifies that no Federal, State, County or Municipal tax will be added to the above quoted prices.
- City of Grand Junction payment terms shall be Net 30 days.
- Prompt payment discount of _____ percent of the net dollar will be offered to the Owner if the invoice is paid within _____ days after the receipt of the invoice. The Owner reserves the right to consider any such discounts when determining the bid award that are no less than Net 10 days.

RECEIPT OF ADDENDA: the undersigned Firm acknowledges receipt of Addenda to the Solicitation, Specifications, and other Contract Documents. State number of Addenda received: _____

It is the responsibility of the Proposer to ensure all Addenda have been received and acknowledged.

Company Name – (Typed or Printed)	Authorized Agent – (Typed or Printed)
Authorized Agent Signature	Phone Number
Address of Offeror	E-mail Address of Agent
City, State, and Zip Code	Date

APPENDIX A

Preliminary Levee Assessment Report

Colorado River Levee

Grand Junction, Colorado

Prepared for:

City of Grand Junction
250 North 5th Street
Grand Junction, CO 81501

Colorado Water Conservation Board
1313 Sherman Street, Room 718
Denver, CO 80203

Prepared by:

Wood Environment &
Infrastructure Solutions, Inc.
2000 S. Colorado Blvd., Ste. 2-1000
Denver, CO 80222
(303) 935-6505

October 27, 2021

Project No. 32790178

This report was prepared exclusively for the City of Grand Junction and the Colorado Water Conservation Board (CWCB) by Wood Environment & Infrastructure, Inc., (Wood). The quality of information, conclusions and estimates contained herein is consistent with the level of effort involved in Wood's services and based on: i) information available at the time of preparation, ii) data supplied by outside sources and iii) the assumptions, conditions and qualifications set forth in this report. This report is intended to be used by only the City of Grand Junction and the CWCB, subject to the terms and conditions of their contract with Wood. Any other use of, or reliance on, this report by any third party is at that party's sole risk.

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LIST OF APPENDICES

LIST OF ACRONYMS

1D	1-Dimensional
2D	2-Dimensional
44 CFR	Title 44 of the Code of Federal Regulations
BFE	Base Flood Elevation
BGS	Below Ground Surface
BLE	Base Level Engineering
CFR	Code of Federal Regulations
CFS	Cubic Feet per Second
CLOMR	Conditional Letter of Map Revision
CMU	Concrete Masonry Unit
CWCB	Colorado Water Conservation Board
D50	Median Diameter
DOE	Department of Energy
EM	Engineering Manual
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
HEC-RAS	Hydrologic Engineering Center's Riverine Analysis System
LiDAR	Light Detection and Ranging
LS	Landside
MAP	Mapping Assessment and Planning
NAVD88	North American Vertical Datum of 1988
NFIP	National Flood Insurance Program
NGVD29	National Geodetic Vertical Datum of 1929
NLD	National Levee Database
O&M	Operation and Maintenance
RCP	Reinforced Concrete Pipe
ROW	Right of Way
RS	Riverside
SPT	Standard Penetration Test
STA	Station
USACE	United States Army Corps of Engineers
USGS	United States Geological Survey
VFZ	Vegetation Free Zone

Preliminary Levee Assessment Report
Colorado River Levee Segment
Grand Junction, Colorado

1.0 Introduction

A Federal Emergency Management Agency (FEMA) Risk Mapping Assessment and Planning (MAP) countywide study is currently underway for Mesa County, which includes new hydraulics for the Colorado River through the County based on updated hydrology for the Colorado River. That project will ultimately result in new floodplain mapping along the Colorado River including the section that flows through Grand Junction, Colorado. Due to new federal requirements, areas behind levees cannot be shown as protected by the levee in updated flood insurance mapping until the levee is shown to meet the requirements presented in Title 44 of the Code of Federal Regulations (44 CFR) 65.10, certified by a licensed professional engineer, and accredited by FEMA.

Currently there is one section of the levee in Grand Junction that is shown as providing protection on the effective Flood Insurance Rap Map (FIRM) Panels 08077C0812F and 08077C0816F and will require accreditation against 44 CFR 65.10 to continue providing protection when the Risk MAP process is complete. This levee segment, officially the Colorado River at Grand Junction levee, is presented in Figure 1 and will be referred to as *the levee* throughout this report. This document summarizes the findings of the Preliminary Levee Assessment for the levee. The preliminary levee assessment and review included data collection, data review, field inspection, and determination of additional data collection and analyses required to satisfy the requirements of 44 CFR 65.10. Wood Environment and Infrastructure Solutions Inc. (Wood) worked with City of Grand Junction officials and the Colorado Water Conservation Board (CWCB), among others, to collect data, view the flood control system, and to acquire and review data collected from other sources.

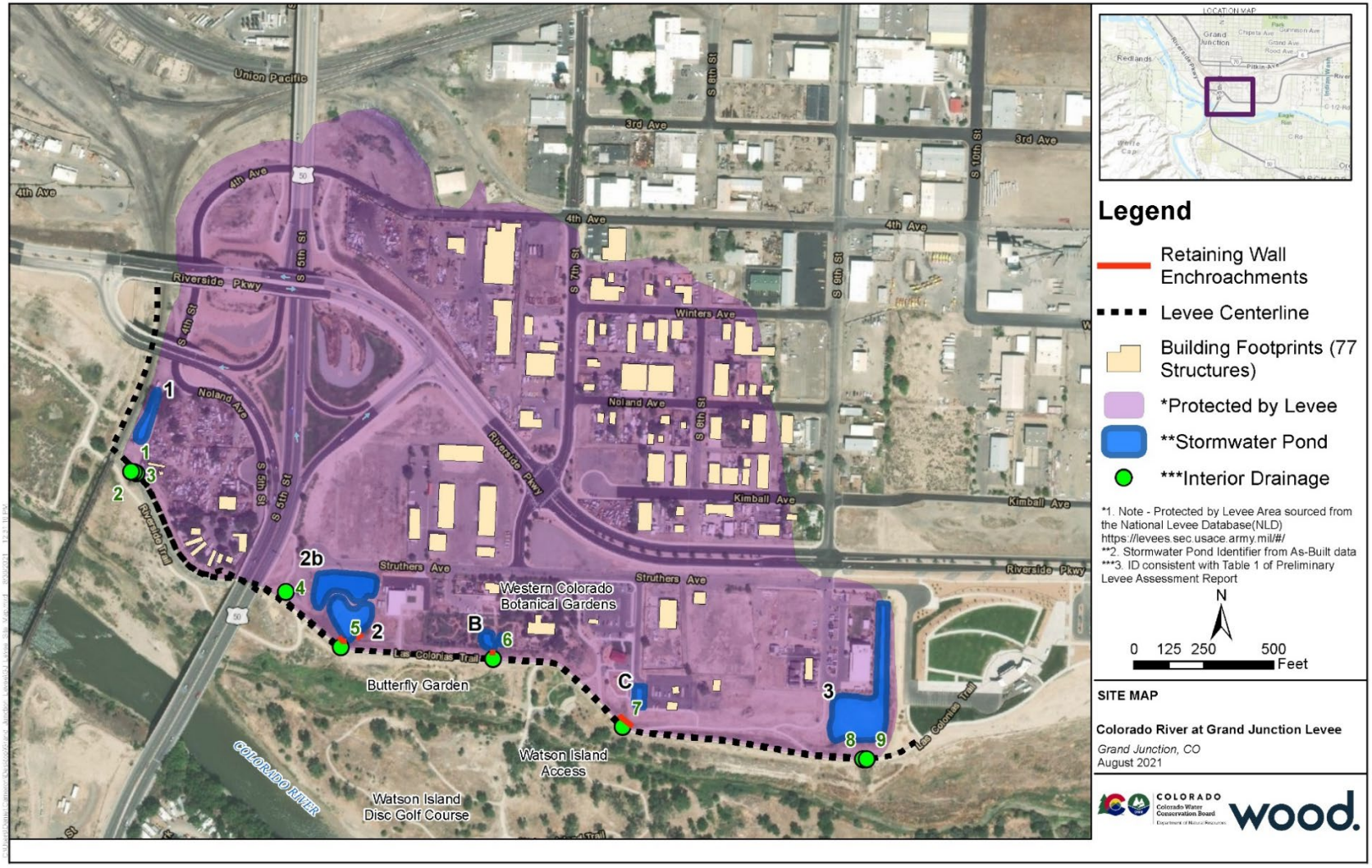

Figure 1: Colorado River Levee Site Map

wood.

1.1 Background

The Colorado River drainage basin at the United States Geological Survey (USGS) Stream Gage at Fruita (09153000) is approximately 17,100 square miles (USGS, 2021). The headwaters originate along the Continental Divide at elevations above 10,000 feet. The river proper starts at Lake Granby in Grand County and flows southwest through mountain valleys and canyons before entering the high desert of the western slope.

Peak flows along the Colorado River have been studied for over 110 years. The most recent study was completed by Wood (previously Amec Foster Wheeler) in 2017. These flows have been accepted by FEMA and will be used in this study for the freeboard analysis. Further information on the flow development can be found in the Conditional Letter of Map Revision (CLOMR) for the Colorado River, Case #: 19-08-0881R. Several large historical floods have been recorded on the Colorado River. The largest flood on record, estimated using high water marks in the vicinity of the gage near Fruita, occurred in June/July of 1884 and was approximately equal to 125,000cfs in magnitude at its peak. This event was caused by the melting of very heavy snow cover (Follansbee and Sawyer, 1948). The second highest flood was in 1921. This flood had a peak flow of approximately 81,100cfs at the USGS gage in Fruita. This flood was also caused primarily by snowmelt runoff, with perhaps a very small rainfall component (Elliott, Jarrett, Ebling, 1982).

To protect against destructive floods, there have been several berms and levees constructed along the Colorado River in and around Grand Junction throughout the 1900s. In addition to the levee being studied, there are three other levee segments listed in the National Levee Database (NLD) within Grand Junction totaling a length of 4.2 miles of levee. However, none of these additional levees are FEMA accredited or shown as providing protection on the effective FIRM. These three other levee segments are not included in this analysis.

The Colorado River at Grand Junction Levee, the levee studied in this report, was constructed in 1997 by the Sacramento office of the United States Army Corps of Engineers (USACE). The levee is approximately 0.7 miles long and located on the right river overbank where US highway 50 crosses the Colorado River. The upstream end of the levee ties into high ground and the downstream end ties into the high ground along the Union Pacific Railroad line. Most of the levee is earthen embankment with the furthest western portion consisting of a clay cap covering the riverside of the railroad embankment. The levee contains nine interior drainage structures and there are six stormwater detention ponds of various sizes along the landside of the levee. Figure 1 presents the levee, the area protected by the levee, and the interior drainage structure locations as well as other items of interest.

1.2 Previous Studies

Data from several sources were utilized for this report. Sources consulted are listed below along with the relevant appendix where the sources are located.

- Levee as-built drawings from 1997 (Appendix A)
- Various City of Grand Junction stormwater as-built drawings from 1965 to 2003 (Appendix A)
- 2016 USACE presentation, for geotechnical information and drainage structure conditions (Appendix G)
- 2019 USACE routine inspection report, for general levee conditions and points of concern (Appendix G)
- Levee profiles created from 2017 survey data (Appendix G)
- Operations and maintenance manual for the levee (Appendix F)
- Geotechnical information from a nearby construction project (Appendix G)
- 2012 FEMA Flood Insurance Studies (FIS) for Mesa County (Appendix B)
- Flood Insurance Rate Maps (FIRM) (Appendix B).
- 2017 Colorado River Hydrology report (Appendix B)

1.3 Vertical Datum

Levee information was found in both the National Geodetic Vertical Datum of 1929 (NGVD29) and the North American Vertical Datum of 1988 (NAVD88). NGVD29 data was converted to NAVD88 using a conversion factor of 3.35ft. Based on the latest FEMA guidance, all information used for eventual certification of the levee will need to be in the currently federally accepted NAVD88 (FEMA, 2014). Additionally, any updates to the effective FIS or FIRMs will also need to be submitted in NAVD88.

1.4 Field Assessment

A field assessment of the levee was completed on April 8th, 2021. Wood employees Chris Ide, P.E., CFM, and Elizabeth Jefferson, E.I. along with Grand Junction City officials visually assessed the integrity, stability, and maintenance of the levee. The current condition and any observed critical features were documented through photographs and field notes.

In general, the levee was found to be well maintained and in good condition. However, it appeared that there were unpermitted levee modifications that could be an issue for levee certification. Additionally, areas along the levee were found to require maintenance attention, typically in the form of vegetation removal or pest control. Most of the areas could be addressed with routine maintenance. However, there may be some larger vegetation, like trees, that may need to be removed prior to certification. Based on this preliminary analysis there were no concerns about instability, erosion, or seepage. Further evaluation of each of these are detailed in the sections below.

1.5 Geotechnical Information

A desktop review was completed for all available geological and geotechnical data. For levee certification and accreditation, further field testing will be required. However, this review is useful in planning future studies and informing potential issues.

Based on a review of the 1997 as-built drawings and US Army Corps of Engineers (USACE) presentation dated May 2016, Wood understands that the design of the levee was supported by two separate geotechnical investigations. Documents (e.g., geotechnical engineering reports or memoranda) that provide a comprehensive assessment for the completed subsurface explorations and engineering analyses were not available for Wood's review.

The 2016 USACE presentation reports that one of the completed geotechnical investigations is documented on pages 10 and 11 of a document prepared by the Department of Energy (DOE), titled "Basis of Design and Cost Estimate", dated February 1991, which was not available for Wood's review. This geotechnical investigation consisted of six exploratory trench excavations and laboratory testing. The exploratory trenches (designated as 4F-90-01 and 4F-90-03 to 4F-90-07) were excavated to depths ranging from 5.5 to 10ft below ground surface (bgs) along the proposed levee alignment in February 1990. Groundwater was reported to be encountered within the exploratory trenches at depths ranging between 5.5 to 9.9ft bgs.

Graphic borehole logs provided on Detail Sheet C-11 of the 1997 as-built drawings indicate an additional geotechnical investigation was performed. The borehole logs indicate that eight (8) boreholes (designated as ST1 to ST8) were explored to depths ranging from 12 to 23ft bgs. Groundwater was reported at depths ranging from 2 and 8ft bgs. The borehole locations provided on the as-built drawings indicate that boreholes were located along the centerline of the levee alignment or within 50ft of the toe. The supporting geotechnical interpretations and laboratory test data that are typically provided in a geotechnical report were not available for

Wood's review. However, USACE (2016) reports that this borehole data likely originates from the 1996 DOE document, which documents a borehole study occurring sometime between 1982 and 1986.

The USACE (2016) presentation indicates that laboratory tests were performed during the 1990 geotechnical study to evaluate soil samples collected from exploratory trenches and potential embankment borrow materials. The laboratory tests included particle-size distribution (gradation) and Atterberg limit (i.e., liquid and plastic limits) analyses to determine soil index properties, which facilitate identification and classification of soils for engineering purposes.

The laboratory test results, and trench logs reported by USACE (2016) indicate that the upper 6 to 9ft of the foundation along the proposed levee alignment consist primarily of a relatively impermeable layer of clay measuring up to 5ft thick with thinner isolated layers of silt, sand, and gravel. The graphic borehole logs provided on the as-built drawings indicate that the upper layer is underlain to a depth of 15 to 20ft by a granular layer of sand, gravel, and cobble; followed by bedrock comprised of Mancos shale to unknown depths, reportedly in excess of 50ft.

The USACE (2016) presentation indicates that the levee embankment materials are comprised of silty sand to sandy lean clay or lean clay soils. However, the source of this information was not provided or referenced in the as-built drawings.

1.6 Levee Compliance with 44 CFR 65.10 Requirements

Levee systems will only be recognized by FEMA and mapped on National Flood Insurance Program (NFIP) maps as showing protection from the 1% annual-chance-exceedance flood event, or base flood, if the levee system meets the requirements described in 44 CFR 65.10 as determined by a certifying engineer. Meeting these requirements includes providing evidence that adequate design, operation, and maintenance systems are in place to provide reasonable assurance of protection from the base flood. The following sections summarize the requirements of 44 CFR 65.10, the findings during the Preliminary Levee Assessment, and recommendations to obtain remaining data or perform additional analyses to determine whether the levee meets the requirements of 44 CFR 65.10.

2.0 Design Criteria

For levees to be recognized by FEMA, evidence that adequate design and operation and maintenance systems are in place to provide reasonable assurance that protection from the base flood exists must be provided. The following requirements must be met as described in 44 CFR 65.10(b). The full text is provided in Appendix G.

- 65.10(b)(1): Freeboard
- 65.10(b)(2): Closures
- 65.10(b)(3): Embankment Protection
- 65.10(b)(4): Embankment and Foundation
- 65.10(b)(5): Settlement Analysis
- 65.10(b)(6): Interior Drainage
- 65.10(b)(7): Other Design Criteria

2.1 Freeboard

Requirement

Riverine levees must provide a minimum of three (3) feet of freeboard above the water surface elevation of the one percent annual chance base flood along the length of the levee. 3.5 feet of freeboard is required at the upstream end of levee, tapering to not less than the minimum at the downstream end of the levee. Additionally, four (4) feet of freeboard is required within 100 feet of hydraulic structures (such as bridges) or wherever the flow is constricted.

Findings

Levee crest elevations based on the levee survey completed in 2017 were compared with draft/preliminary base flood elevations (BFE) from the ongoing study along the Colorado River to estimate freeboard along the levee. Preliminary cross sections, flood extents, and BFEs from the ongoing study are presented in Figure 2. The BFEs, levee crest elevations, and required freeboard elevations along the levee are shown in Figure 3. The available freeboard and required freeboard are presented in Figure 4 for an alternative comparison. Stations along the portion of the levee that consists of a clay cap over the existing railroad embankment were given negative stationing values for plotting purposes. The results of the preliminary freeboard assessment show that there is one area just upstream of the Union Pacific Railroad bridge where the levee is currently freeboard deficient for approximately 150ft. The maximum deficiency is approximately 1.1ft. A couple of reasons for the deficiency were identified:

- From a comparison of the 2017 survey data with the levee as-built information, it appears that the crest of levee is approximately 0.5ft lower than the design/as-built elevation at the location of the deficiency.
- Preliminary results from the updated Colorado River modeling show that there may be an increase in the effective base flood elevation at this location. Further investigation points to sedimentation within the Colorado River immediately upstream and downstream of the railroad crossing being the primary cause for the increase. This is discussed more in the embankment protection section of this report.

Figure 5 shows a levee plan view of the locations where freeboard is acceptable or deficient. Appendix C includes the calculations used to determine freeboard deficiencies and to create the following figures. The

preliminary hydraulic model from the ongoing countywide study was not included with this submittal. Once the model has been finalized it will be available under MIP Case #20-08-0021S.

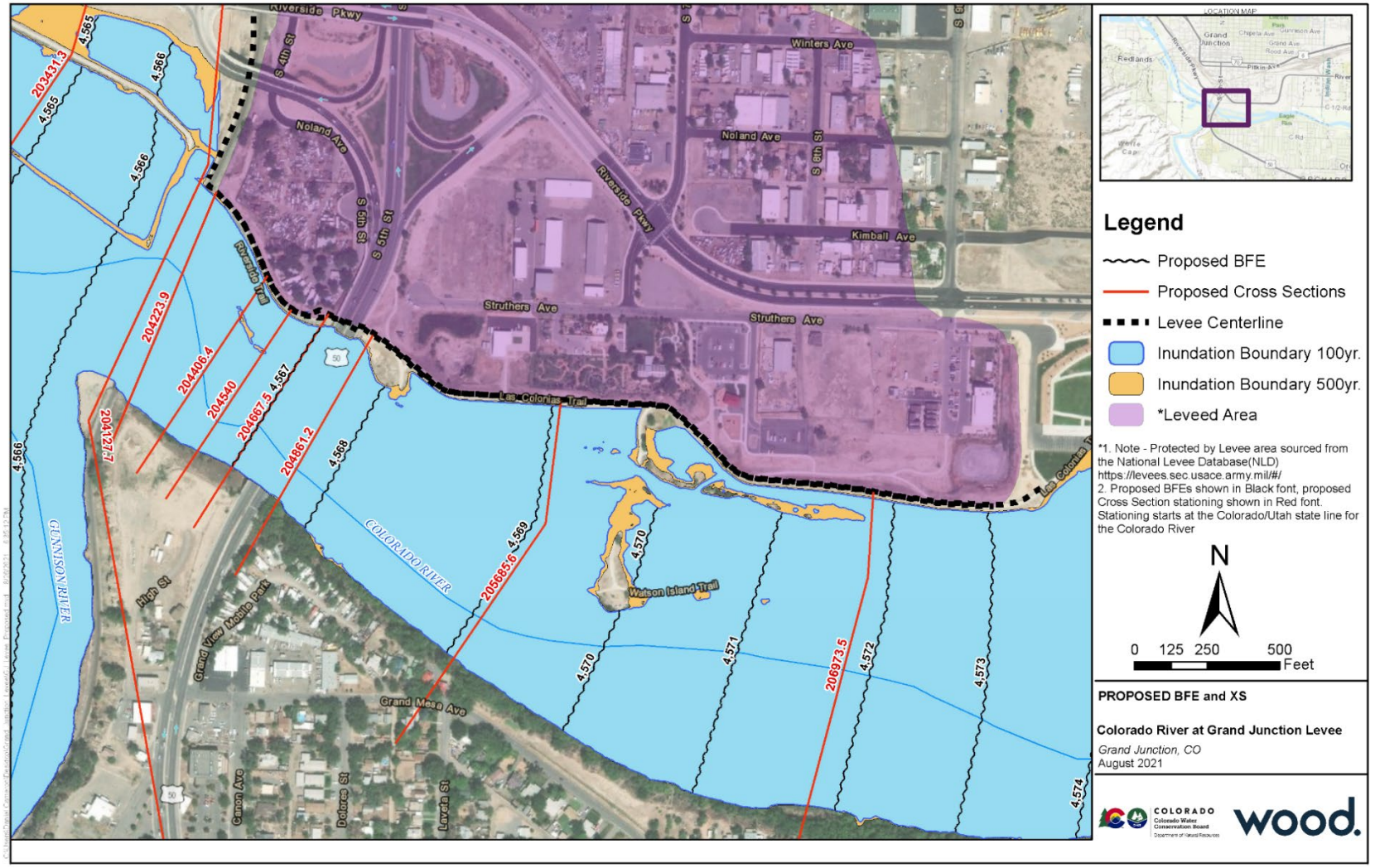

Figure 2: Preliminary Base Flood Elevations and Cross-Section Placement from Ongoing Colorado River Study

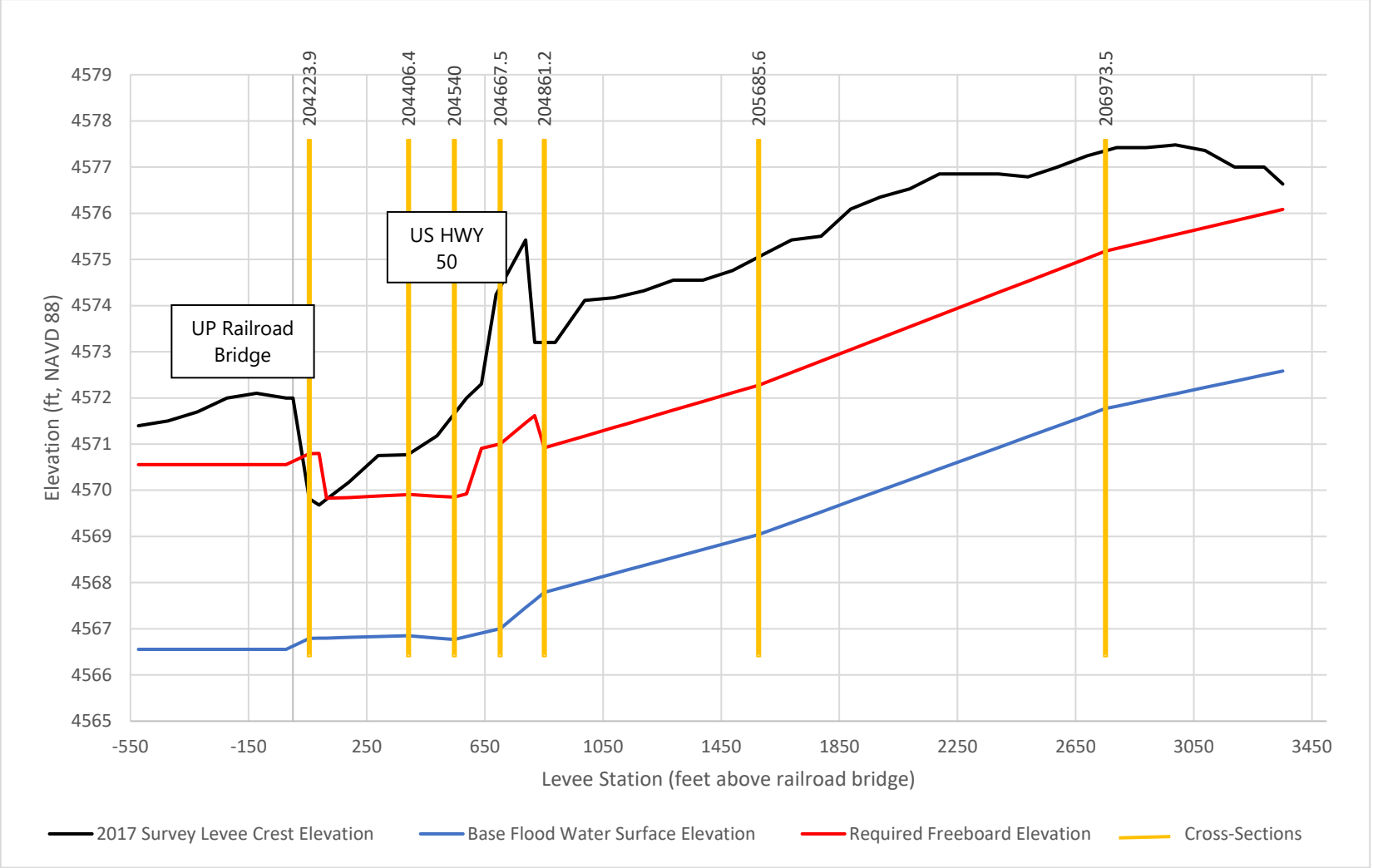

Figure 3: Preliminary Freeboard Analysis Profile

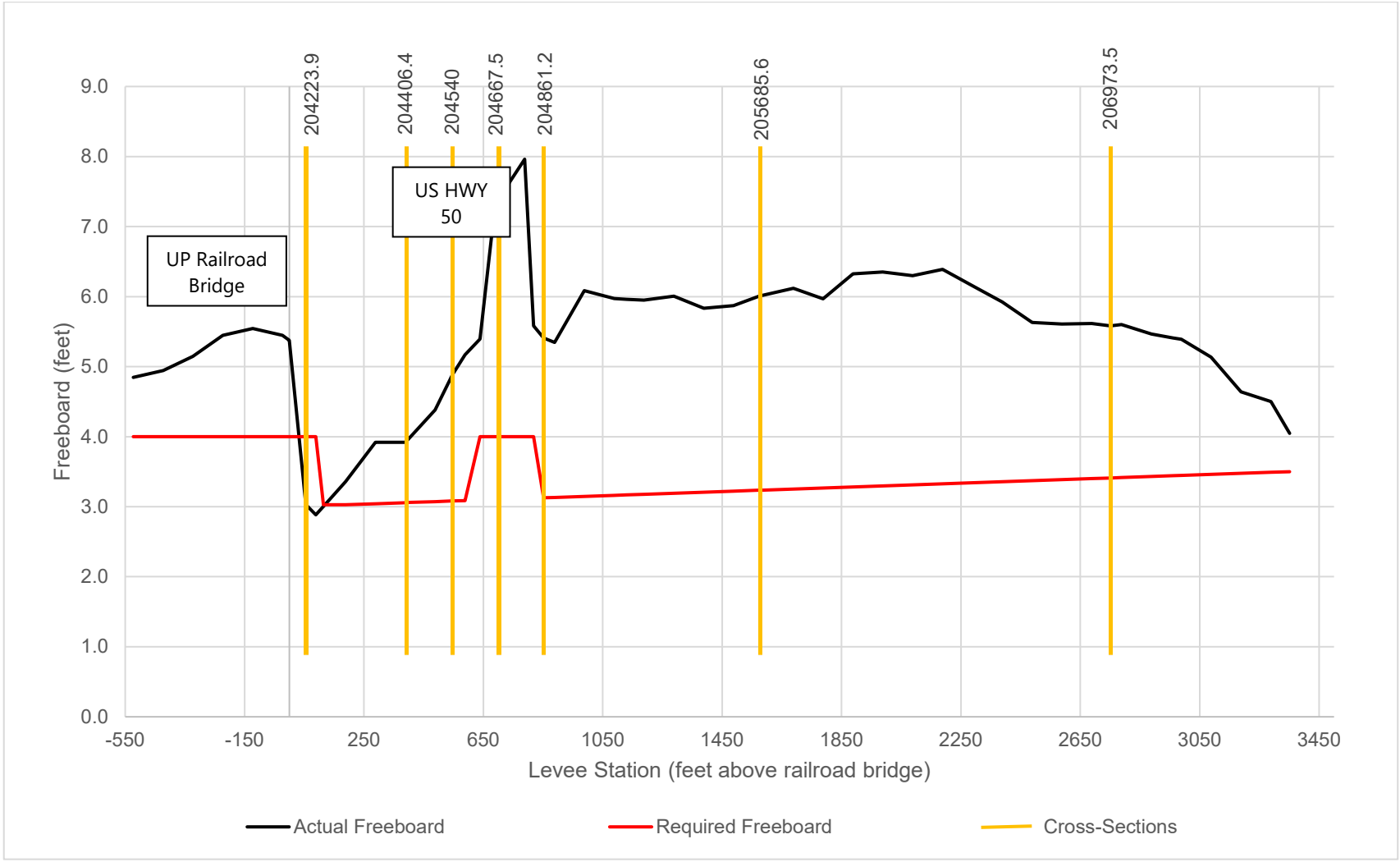

Figure 4: Preliminary Required and Available Freeboard Comparison

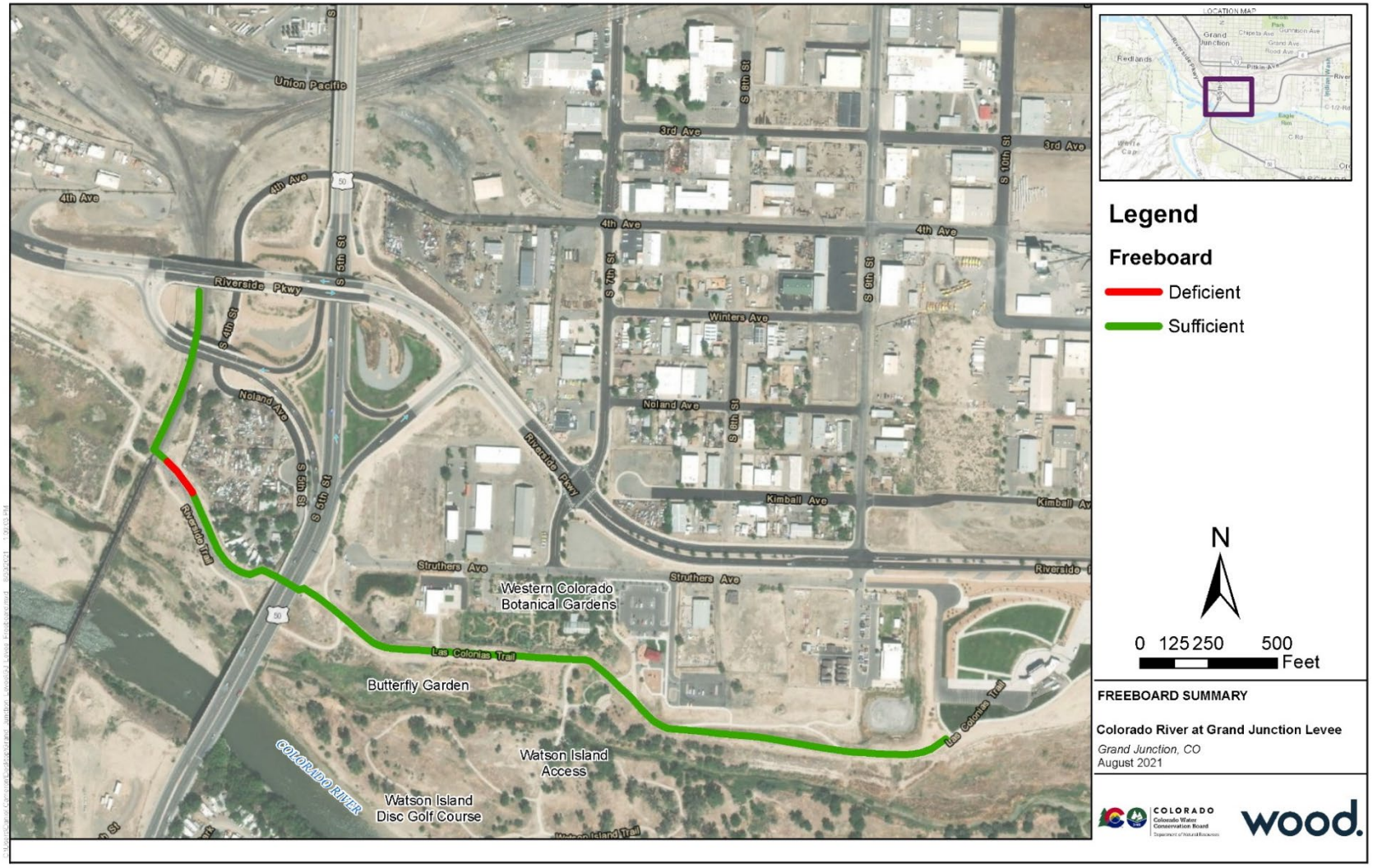

Figure 5: Preliminary Freeboard Summary

wood.

Recommended Actions

New survey information should be obtained for the levee crest elevations along the levee. These updated levee crest elevations should be compared to the Colorado River hydraulic model results once modeling is complete and the model has been approved by FEMA. This comparison will produce a more accurate freeboard assessment and can be used as the final determination for any freeboard deficiencies. If deficiencies still exist, options to bring the levee into compliance include:

- Raise this section of levee by approximately 1-foot in order to meet the freeboard requirement. This would require an engineered design because the levee needs to structurally withstand the base flood.
- Dredge the channel of the Colorado River through this area to lower the base flood elevation.

As mentioned above, based on preliminary modeling results, sedimentation and reduced channel capacity around the railroad bridge appear to be the primary factors leading to the increase in the base flood elevation at the point of freeboard deficiency. This is supported by historical aerial imagery which shows a tendency for sandbars to develop and shift at this location. This is described further in the Embankment Protection section of this report. That stated, if the second option is selected for achieving adequate freeboard, further hydraulic modeling will be necessary to plan the scope of work and to prove that the channel modifications will achieve the desired outcome. Hydraulic modeling could also be used to determine the approximate amount of sediment removal necessary. Additionally, it is important to note that dredging may need to be a routine maintenance item in order to maintain channel capacity as it is likely that the river will tend to redeposit sediment in this location. Sediment transport modeling could be used to estimate the required frequency of dredging to maintain capacity. Note that alterations to the levee, other than to restore it to its original as-built design would trigger a USACE 408 permit. Any work within the Colorado River would trigger a regulatory permit for work within the Waters of the United States.

2.2 Closures

Requirement

All levee openings and penetrations for interior drainage must be provided, with closure devices that are structural parts of the levee system during operation, and designed according to sound engineering practices.

Findings

The levee has no openings that require a specialized levee closure to be operated during flood conditions. There are nine interior drainage structures penetrating the levee. All the interior drainage structures are associated with one of the six stormwater detention ponds located on the landside of the levee as presented in Figure 1. It appears that some of the ponds have been modified, perhaps for increased capacity, since their original construction. Of the nine interior drainage structures, seven were identified in the USACE 1997 as-built plans. The two outfall pipes from stormwater detention pond 3 were constructed after the original levee construction and noted as being built without a permit in the 2019 USACE inspection report. It appears that these new crossings replaced an original 18" interior drainage structure. Table 1 provides the location of the as-built information for each crossing. All as-built information is located in Appendix A. During the field assessment, all nine of the interior drainage structures were found and their conditions documented. Table 1 summarizes the interior drainage structures, their current condition, and the action that needs to take place for certification purposes. Pictures of the structures are included in Appendix H.

Recommendations

The actions specified in Table 1 for each interior drainage structure need to take place so that each structure can adequately operate for certification purposes.

Table 1: Interior Drainage and Closure Summary

	As-Built Information								Current Conditions		Action
ID	As-Built Station	Source	Description	Size (inches)	Material	Backflow Preventer RS	Backflow Preventer LS	As-Built Notes	Condition	Notes	
1	01+44.00	USACE 1997, page C-7	Drains stormwater detention pond 1 (C3-261-904).	18	RCP	Flap	Slide		Good	Standing water on riverside, drained by 42-in pipe under sidewalk.	Ponded water is likely not an issue as it is unlikely that it is creating seepage paths through the levee. However, should correct drainage issue or complete geotechnical investigation. This is discussed further in Section 2.4.
2	01+44.00	USACE 1997, page C-7	Drains stormwater detention pond 1 (C3-261-904).	36	RCP	Flap	Slide	Labeled as a 20" crossing in USACE 1997 as-built profile	Good	Same as crossing 1	Same as crossing 1 plus revise as-built data
3	01+44.00	City of Grand Junction 1965, sheet 1	Drains stormwater detention pond 1 (C3-261-904).	36	RCP	Flap	Slide		Good	Same as crossing 1	Same as crossing 1
4	8+80.00	City of Grand Junction 1970, sheet 4	Drains stormwater detention pond 2b (C2-261-901)	18	RCP	Flap	Slide	Labeled as existing 36" in USACE 1997 as-builts - believed to be mislabeled	Poor	Circumferential crack found in USACE 2011 video inspection. Barb wire fence restricting access to landside gate. Standing water on landside of levee.	Repair crack if not already repaired. Provide access to landside gate. Ponded water may create seepage paths. Geotechnical investigation required, see Section 2.4.
5	11+61.00	USACE 1997, page C-7	Drains stormwater detention pond 2 (C2-261-902).	18	RCP	Flap	Slide		Excellent	Wall at pond outlet and barb wire fence restricting access to landside gate see Table 5	Recommend remove retaining wall, repair levee, and extend pipe. Provide access to landside gate. See Section 2.7.2 for more details.
6	18+55.00	USACE 1997, page C-5a	Drains stormwater detention pond B (Botanical Gardens).	18	RCP	Flap	Slide	Relocated in as-builts see C-5a	Excellent	Wall at outlet and fence restricting access to landside gate see Table 5. Standing water on landside of levee. Sediment and vegetation around outfall.	Ponded water may create seepage paths. Geotechnical investigation required, see Section 2.4. Recommend remove retaining wall, repair levee, and extend pipe. Provide access plan for landside gate in O&M manual. See Section 2.7.2 for more details. Remove plants and sediment around outfall.
7	22+15.00	USACE 1997, page C-5a	Drains stormwater detention pond C (C2-262-902).	18	RCP	Flap	Slide	Relocated in as-builts see C-5a	Good	Wall at outlet and see Table 4 - Encroachments	Recommend remove retaining wall, repair levee, and extend pipe. See Section 2.7.2 for more details.
8	29+90.00	City of Grand Junction 2003, page 8	Drains stormwater detention pond 3 (C2-262-901).	32 x 72	RCP	Flap	Slide	Built after levee completion, no USACE permit	Excellent	Standing water on landside of levee.	Ponded water may create seepage paths. Geotechnical investigation required, see Section 2.4.
9	29+90.00	City of Grand Junction 2003, page 8	Drains stormwater detention pond 3 (C2-262-901).	32 x 72	RCP	Flap	Slide	Built after levee completion, no USACE permit	Excellent	Same as crossing 8.	Same as crossing 8.

RCP – Reinforced Concrete Pipe

2.3 Embankment Protection

Requirement

Engineering analyses must be submitted that demonstrate that no appreciable erosion of the levee embankment can be expected during the base flood, as a result of either currents or waves, and that anticipated erosion will not result in failure of the levee embankment or foundation directly or indirectly through reduction of the seepage path and subsequent instability.

Findings

Based on available as-built information, the original levee was constructed with a 15" thick layer of riprap embedded to a depth of 6" from levee station 0+53 to 7+03, which is the extent between the Union Pacific Railroad bridge and the US HWY 50 bridge. During the field visit and based on aerial imagery, it was noted that the riprap extends beyond the design to about 100-ft upstream of the upstream face of the US HWY 50 bridge. The as-builts do not provide a median diameter (D50) for the riprap, but it was estimated at 24" during the field visit. Since the levee was constructed there has not been a large enough flood to cause any damage to the levee or to test the existing embankment protection. Outside of the riprap protected areas, there is very minor erosion along the levee that is noted in subsequent sections of this report. There is no known history of erosion issues with this levee that would contribute to levee failure.

To determine whether the existing riprap revetment was sufficient to protect the levee embankment and to determine whether additional protection was necessary, two major factors were considered. The first factor was whether the levee was likely to scour based on hydraulic modeling results from the existing conditions, and the second was whether the river was likely to migrate toward the levee over time, exposing the levee to greater erosional forces.

The preliminary hydraulic model for the Colorado River from the ongoing countywide study was used to estimate existing scour potentials along the levee. Average shear stresses and velocities for the right overbank, where the levee is located, are presented in Table 2. Model results were then compared to the maximum allowable shear stresses and velocities that various channel linings can withstand provided in the reference *HEC-15 Design of Roadside Channels with Flexible Linings (*FHWA, 2005). From HEC-15 Table 865.2, included in Appendix D, long native grasses can withstand shear stresses of up to 1.7 lb/ft^2 and velocities as high as 6ft/s. Short native grasses can withstand shear stresses of 0.95 lb/ft^2 and velocities of 4ft/s. Based on these values and the model results, well seeded native grasses should provide sufficient protection for the entire length of levee.

Table 2: Estimated Existing Shear Stresses and Velocities Along the Levee Embankment

Hydraulic Model Cross-Section	Levee Station	Right Overbank Velocity (ft/s)	Right Overbank Shear Stress (lb/ft2)	Additional Protection Required?
207973.6	45+31	2.5	0.44	NO
206973.5	27+51	2.79	0.48	NO
205685.6	15+76	2.45	0.4	NO
204861.2	08+51	3.52	0.67	NO
204667.5	07+01	2.58	0.33	NO
204540	05+46	2.58	0.34	NO
204406.4	03+91	2.16	0.22	NO
204223.9	00+55	2.96	0.36	NO
204127.7	-00+41	3.61	0.51	NO

To evaluate the potential for increased risk overtime, site geomorphology was considered. *HEC-20 Stream Stability at Highway Structures* (FHWA, 2012) provides guidance for evaluating stream migration potential. There are many geomorphic factors that influence stream stability and the likelihood of stream migration overtime. Major factors include stream size, flow habit, bed material, valley setting, floodplains, natural levees, apparent incision, channel boundaries, tree cover, sinuosity, braided streams, anabranched streams, and variability and width of bars. Not all these factors were investigated during this preliminary assessment, due to the preliminary nature of this analysis and lack of field data. A couple of factors of note are described below along with their potential impacts on levee embankment protection.

Sections 2.3.11 and 2.3.12 of HEC-20 discuss braided streams and anabranched streams. According to the manual, a braided stream "*consists of multiple and interlacing channels*" and usually contains "*multiple, mid-channel islands and bars.*" Anabranched streams are different "*in that the flow is divided by islands rather than bars, and the islands are large relative to channel width [...] The anabranches, or individual channels, are more widely and distinctly separated and more fixed in position than the braids of a braided stream.*" The Colorado River at the levee site has characteristics of both a braided and an anabranched stream. Upon reviewing historical imagery, it appears that Watson Island, the large island upstream of US HWY 50, has been relatively fixed overtime. The island is also vegetated with large trees and the channel between the island and the levee has not changed significantly over time. The smaller island under the railroad bridge, however, is much more indicative of braided stream flow behavior. The island has changed significantly over time from being centered in the channel in 1993, with relatively equal conveyance on either side, to being farther to the right of the channel in more recent imagery. This island appears sandy and is vegetated only by small brushes and grasses. Figure 6 presents historical imagery courtesy of Google Earth which shows these changes through time.

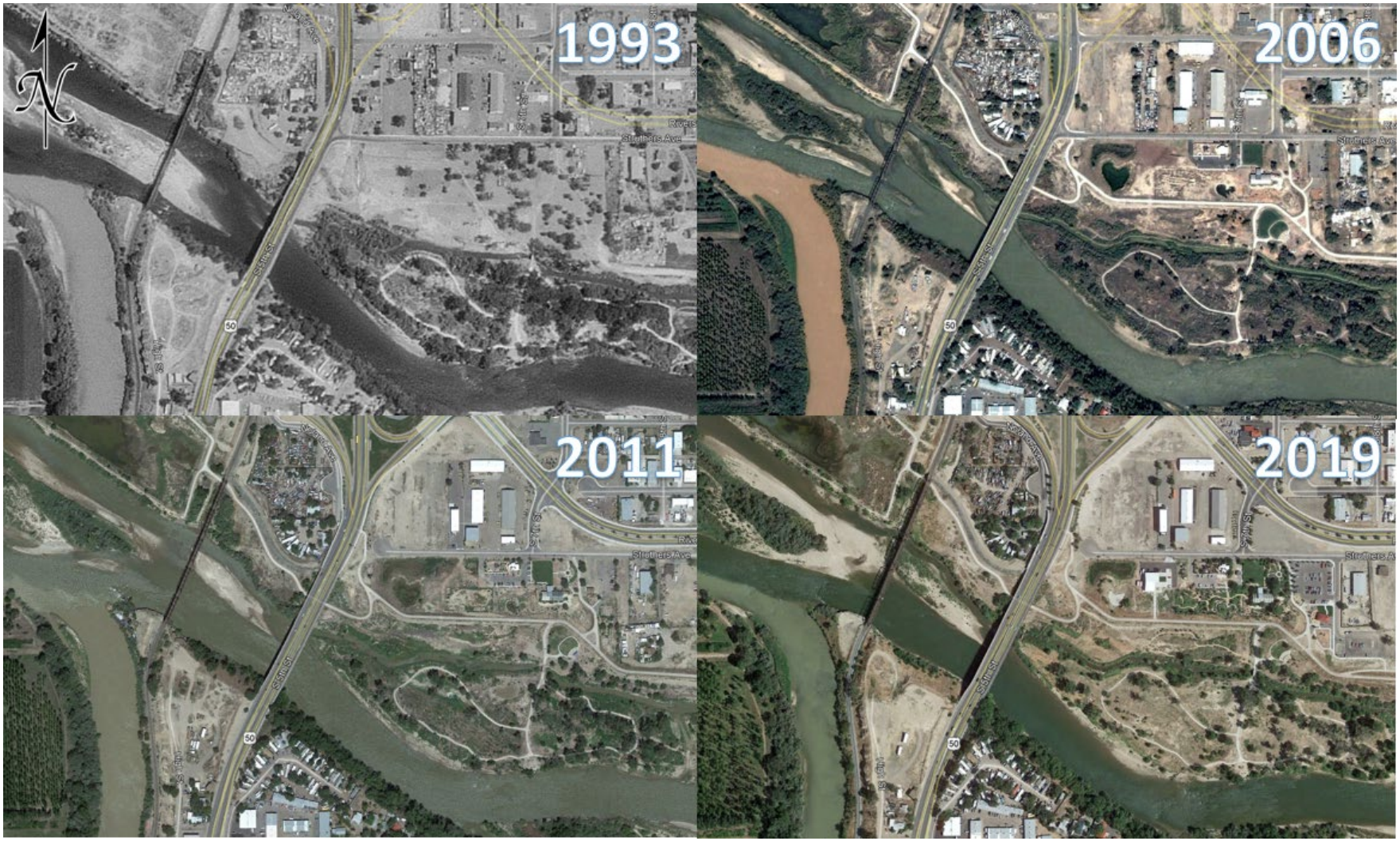

Figure 6: Channel Migration Over Time

Overall, this preliminary assessment indicates that the channel along the upper portion of the levee is relatively stable and not likely to migrate over time, or if migration does occur it will likely happen slowly. The channel around the railroad bridge, however, appears to migrate regularly and might change significantly during a flood event. Section 2.3.11 of HEC-20 notes this about braided channels, "*The presence of bars obstructs flow and scour occurs, either lateral erosion of banks on both sides of the bar, scour of the channels surrounding the bar, or both. This erosion will enlarge the channel and, with reduced water levels, an island may form at the site of a gravel or sand bar. The worst case will be where a major bar or island forms at a bridge site. This can produce erosion of both banks of the stream and bed scour along both sides of the island. Reduction in the flow capacity beneath the bridge can result as a vegetated island forms under the bridge. An island or bar that forms upstream or downstream of a bridge can change flow alignment and create bank erosion or scour problems at the bridge site.*"

Based on this information, it is not unreasonable to assume that over time or during a major flood event the main conveyance path for the Colorado River could shift toward the right bank where the levee is located. In this situation, the levee would be exposed to greater velocities and shear stresses than the hydraulic model estimated for the right overbank, because the model was developed based on the current river geometry. To have a conservative estimate of the embankment protection necessary to protect the levee during such a situation, the shear stresses and velocities for the main channel of the Colorado River were used to estimate riprap sizing based on guidance from HEC-15. As previously noted, this portion of the levee is already armored with riprap that has a D50 of approximately 24 inches. Table 3 shows the results.

Table 3: Estimated Potential Shear Stresses and Velocities Along the Levee Embankment

Hydraulic Model Cross-Section	Levee Station	Mean Channel Velocity (ft/s)	Main Channel Shear Stress (lb/ft2)	Riprap D50 Required (in)	Additional Protection Required?
204667.5	07+01	10.39	1.57	6	NO
204540	05+46	10.26	1.57	6	NO
204406.4	03+91	8.75	1.14	6	NO
204223.9	00+55	7.54	0.85	3	NO
204127.7	-00+41	7.97	0.97	3	NO

Recommendations

Based on this preliminary assessment, the existing embankment protection appears to be sufficient for the entire length of levee as long as native vegetation is established and well maintained on all non-riprap reinforced sections of the riverside embankment. The existing riprap appears to be conservatively sized and in good condition. However, this is a high-level review of potential issues, and not an in-depth investigation. Knowing that geomorphologic conditions at the site make stream migration likely, it is recommended that further investigation into stream geomorphology be completed to assure that there are no other potential impacts related to stream migration over time. Additionally, it is recommended that a two-dimensional (2D) hydraulic model be developed for more accurate estimates of scour potential. Two dimensional models are better suited for estimating scour because they allow for flow to move in any direction and allow for more variability in flow

velocities and momentum. Additionally, 2D models are better at handling split flow and braided stream scenarios. A one-dimensional (1D) model assumes a uniform flow direction and interpolates channel geometry between cross-sections. Although this is reasonably accurate at large scales, for example for use in floodplain mapping, it does not provide as detailed of information for discrete locations. A 2D model for the river reach along the levee would provide more accurate scour estimates.

2.4 Embankment and Foundation

Requirement

For each unique levee segment which is based on construction type, embankment soil, foundation conditions, etc., engineering analyses that evaluate levee embankment stability must be submitted. The analyses provided shall evaluate expected seepage during loading conditions associated with the base flood and shall demonstrate that seepage into or through the levee foundation and embankment will not jeopardize embankment or foundation stability. An alternative seismic analysis demonstrating that the levee is designed and constructed for stability against earthquake loading conditions, as defined in Chapter 6, Section II, Case IV of the USACE levee design manual, should be considered if warranted by the severity of the expected seismic event (USACE, 2000).

Findings

Wood has performed a review of the USACE 1997 as-built drawings which provide information regarding the site topography (prior to construction), plan and profile, and detail sheets. The as-built drawings indicate that the maximum vertical height between the levee crest and natural grade is approximately 9ft (between STA 11+50 to 13+00), and that the typical levee embankment cross section geometry has a 12-foot-wide crest with riverside and landside slope ratios of 2.5H:1V (horizontal: vertical) and 2.0H:1V, respectively. Wood's field observations of the levee embankment geometry are consistent with those documented on the as-built drawings.

The levee design also includes two relief wells located along the landside levee toe near station 3+00 and 6+00. Based on conversations with the community and the USACE, the original levee design may have included more than the two existing relief wells. Relief wells provide pressure relief for elevated pore-water pressures or artesian conditions that can develop on the landside of levees, which develop when an impermeable clay layer is underlain by a pervious sand layer, as in the case for the Colorado River Levee. This potentially unstable condition can result in significant upward flow and possibly artesian conditions where sand is present near the toe of the embankment. Consequently, the pore-water pressures and corresponding flow can reduce stability and even lead to sand boils and piping. The functionality and necessity of the relief wells cannot be evaluated from the information available.

Overall, the as-built drawings provided for review appear to be in order and are stamped by a professional engineer to meet the requirements of FEMA Title 44, Part 65, Section 65.10, subsection (e). However, the drawings have been revised in several locations and may not reflect the current levee conditions. It is recommended that they be revised as described in Section 5.0 of this report.

Previously completed analyses and engineering computations that evaluated levee embankment stability were not available for review by Wood. It is unclear whether these calculations exist, as they were not mentioned in the USACE-provided documents. Without documentation providing the evaluated levee embankment cross section locations, methodology, and calculations, Wood cannot validate the stability of existing levee embankments and more data is needed for certification. However, it is Wood's opinion that the geometric configuration of the levee embankment has an inherent low risk of slope instability for the following reasons:

- Moderate height (less than 25ft)
- Less than 2.0H:1V riverside slope (generally accepted as the steepest slope that can adequately support riprap)
- Less than 3.0H:1V landside slope (readily traversable with conventional mowing equipment and pedestrian traffic during inspections)
- Crown width greater than 10ft (provides adequate access for maintenance and flood-fighting operations)
- No prior repairs or problem areas have been reported

Overall, it is Wood's opinion that the current condition of the levee is acceptable; however, deficient conditions exist that require improvements/corrective action. Although the levee will essentially function as intended, it will operate with less reliability than what should be provided, if not corrected.

Minor erosion was observed at a few locations along the levee embankment during Wood's field assessment. The most notable erosion cut into the levee less than 6" and appeared to be associated with pedestrian traffic. No deep-seated slides, sloughs, cracking, or depressions associated with slope instability were evident.

Longitudinal and/or transverse cracking were observed along the concrete pedestrian sidewalk situated on portions of the levee crown, which was reportedly constructed upon completion of the levee or sometime shortly after. Based on the low degree of separation between the cracked portions of sidewalk and the relatively level levee crown outside of paved areas, the cracks do not appear to be associated with slope instability.

Several small animal burrows were observed along the portion of the levee created by capping the existing railroad embankment. These burrows appear to be 6to 12 inches in diameter and penetrate the levee embankment. Additionally, numerous large anthills were observed along the portion of the levee not covered by a sidewalk. These burrows are not significant to the extent that the levee is at immediate risk for instability. However, the presence of these burrows on the slope of levee embankments can potentially shorten seepage paths, increase seepage volumes, decrease the factor of safety against slope failure, and increase the risk of internal erosion of embankment materials, which may result in piping during flooding. Photos of the animal burrows and anthills are included in Appendix H.

As summarized in Table 1, ponded water against the levee was observed at four locations, stormwater detention ponds 2b, B, and 3 and at the riverside of the outfalls from stormwater detention pond 1. During a storm event it is expected that there will be water in all of the stormwater detention ponds as the ponds were constructed for stormwater management purposes. In general, the ponding areas against the levee should not pose an issue for certification as long as they are properly evaluated. Having standing water along the levee could impact the phreatic surface causing seepage paths through the levee which could create weak zones, and hence why the evaluation is necessary.

The ponded water at the outfall of stormwater detention pond 1 likely will not impact the phreatic surface and cause seepage through the levee since it is on the riverside of the levee and the topography slopes away from the levee toward the river. Stormwater detention pond B at the Botanical Gardens appears to have been constructed within the lower portion of the levee slope and the side along the levee is lined with large boulders. This area was inaccessible during Wood's site assessment, but the slope appears stable. This kind of encroachment into the levee slope is generally unacceptable and further analysis is required to evaluate the implications of the design if the City wishes to maintain the current configuration. There are a few additional

encroachments that cut into the levee slope associated with the stormwater detention ponds. These are discussed further in Section 2.7.2.

Recommended Actions

Since documentation of the geotechnical analyses completed to support the original levee design is unavailable, an additional geotechnical investigation to evaluate the subsurface conditions along the existing levee alignment will be necessary for certification. The investigation should include a subsurface exploration consisting of boreholes, laboratory testing, and comprehensive geotechnical assessment of collected subsurface data. To ensure a wide spatial distribution of geotechnical data is obtained, boreholes should be spaced no greater than 1,000ft on-center along the levee alignment; closer spacing may be needed where levee embankment or foundation conditions are inconsistent. Where feasible, boreholes should also be drilled occasionally along the levee embankment toe. Boreholes should be drilled sufficiently deep to characterize the levee embankment and foundation conditions within any potential slope failure surface. Drilling should be performed in accordance with guidance provided by USACE (2014b) for drilling in earth embankment dams and levees. The limited geotechnical data available from historical subsurface explorations should be reviewed to facilitate the planning of any additional boreholes and evaluated during further geotechnical analyses.

As previously mentioned, the available information does not provide a basis for the design of the existing relief wells with respect to their locations, installation details, and intent. Therefore, the proposed geotechnical analyses should include an evaluation of the existing relief wells to determine if they adequately serve their intended function. If the existing relief wells are found to be unnecessary for levee stability based on the analysis, they may be abandoned during the certification process. Otherwise, the wells will need to continue to be maintained as described in the Operations and Maintenance Manual. It is also possible that the geotechnical analysis will show that additional relief wells are necessary for levee stability, which may be likely as similar geotechnical conditions exist elsewhere across the levee.

An itemized checklist of FEMA Form FF-FY-21-102 requirements for geotechnical analyses to evaluate embankment and foundation stability is provided in Table 4. These stability analyses are required to evaluate the levee against shear failure for various loading conditions, including the end of construction, during sudden (also known as rapid) drawdown, critical flood stage, steady state seepage at flood stage, and seismic loading. The principal methods used to analyze levee embankments for stability against shear failure assume a sliding surface within the foundation and/or the embankment or a composite failure surface through the foundation and embankment. USACE standards in Engineering Manual (EM) 1110-2-1902 (USACE, 2003) provide guidance for analyzing the stability of embankment slopes, which are typically performed using different commercially available computer programs under the current state of geotechnical practice.

Table 4: Summary of FEMA Requirements for Embankment and Foundation Stability

Requirement No.	FEMA Form FF-FY-21-102 Requirements
5	**Embankment and Foundation Stability**
a	Identified locations and basis for selection of critical location for stability analysis
b	Specified embankment stability analysis methodology used (e.g., circular arc, sliding block, infinite slope, etc.)
c	Summary of stability analysis results (e.g., end of construction, sudden drawdown, critical flood stage, steady state seepage at flood stage, and earthquake)
d	Seepage analysis for the embankment
e	Specified seepage analysis methodology used
f	Uplift pressures at the embankment landside toe checked
g	Seepage exit gradients checked for piping potential
h	Duration of the base flood hydrograph against the embankment

The levee should be inspected periodically, including before flood season and immediately following major high-water periods to identify any unusual settlements, sloughing, caving, seepage, and boils. A discussion of specific maintenance items based on field observations and recommendations for corrective actions are discussed below.

The mild erosion along the levee observed during the field visit appears to result from surface runoff and pedestrian traffic and requires periodic maintenance to repair. Over a period, surface erosion can progressively damage the levee embankment by creating preferred water seepage paths through eroded portions of the levee and through destabilization caused by volumetric loss of embankment soils. Where possible, the native grass and weeds should be kept in-place to provide erosion protection for the levee slopes. Bare areas on an embankment are more susceptible to erosion which can lead to localized stability problems such as small slides and sloughs. Bare areas should be repaired by establishing grass/weed cover or by installing other protective cover (e.g., sod, asphalt, gravel, riprap, etc.). Provided the existing grass and weeds are mowed regularly to increase visibility, the use of grass and weeds for protective cover is an effective and inexpensive way to prevent erosion of embankment surfaces.

Wood understands that the levee embankment materials are comprised of clayey materials. Therefore, surficial shrinkage cracking is expected where levee materials are dry. Shrinkage cracks are typically narrow and shallow, not exceeding a few inches, but may extend as much as 2ft during periods of extreme drought (USACE, 2006). These shrinkage cracks may appear on any paved surface such as the sidewalk. Where cracks are excessive, they should be evaluated (e.g., potholing to determine if crack is present below sidewalk and determine the depth) by a geotechnical engineer to determine if they undermine levee stability and what type of corrective action is required. No such cracks were observed during the field visit.

Animal and insect burrows that are identified should be thoroughly excavated to identify potential seepage concerns and evaluate the stability of the existing levee embankments and inspected, backfilled with compacted soil in 6-inch-thick lifts with similar levee materials. Plans to prevent new burrows should be implemented in accordance with the FEMA (2005) document titled "Technical Manual for Dam Owners - Impacts of Animals on Earthen Dams – FEMA 473", which provide animal specific control measures for rodent and ant management methods. Re-inspection should be performed on a routine basis as an operations and maintenance item after all observed burrows have been properly repaired.

As discussed, further analysis should be completed for all the stormwater detention ponds along the landside of the levee to evaluate their impacts on the phreatic surface and their potential to cause instability. The encroachment associated with stormwater detention pond B as well as other encroachments is discussed further in Section 2.7.2.

The O&M manual prepared by the USACE provides periodic inspection procedures and checklists to be performed semi-annually. Among the inspection checklist items addressed in the Operations and Maintenance (O&M) Manual, deficiencies such as the erosion and animal burrows are to be recorded and included in report submittals to the USACE District Engineer for further evaluation, if needed. Wood recommends the City of Grand Junction adhere to the periodic inspection and reporting procedures outlined in the O&M manual to maintain proper operation of the levee.

2.5 Settlement Analysis

Requirement

Engineering analyses must be submitted that assess the potential and magnitude of future losses of freeboard as a result of levee settlement and demonstrate that freeboard will be maintained. These analyses must address embankment loads, compressibility of embankment soils, compressibility of foundation soils, age of the levee system, and construction compaction methods. In addition, detailed settlement analysis using procedures such as those described in the USACE Settlement Analysis manual must be submitted for each reach of levee and/or floodwall (USACE 1990).

Findings

Wood did not observe evidence of settlement (e.g., localized differential settlement, sags, or depressions) along the levee alignments which could negatively affect the freeboard during the field assessment.

Previously completed analyses and engineering computations that evaluate levee settlement were not available for review by Wood. It is unclear whether these calculations exist or if any assumptions were made for settlement as they were not mentioned in the USACE-provided documents. Post-construction settlement of an earth embankment can occur from the consolidation of both embankment and foundation material subjected to any load, which can result in loss of freeboard or damage to appurtenant structures.

Where foundation and embankment soils are granular (sandy), most of the settlement will occur during construction. For cohesive (clayey) soils, settlement usually takes place over a greater period after construction. The degree and time for this settlement to occur is dependent on the consolidation characteristics of soils, including stress history, drainage paths, and hydraulic conductivity. The levee embankment and foundation materials primarily consist of clayey materials. Therefore, a proper settlement analysis will need to be performed to meet the FEMA certification requirements.

It is Wood's opinion that any remaining settlement since completion of the levee will be minimal or negligible for the following reasons:

- The levee is older than 25 years (most of the consolidation may have already occurred for clayey embankment and upper foundation materials)
- The settlement of lower granular foundation soils would have occurred during construction.

Recommended Actions

As part of the certification process, Wood recommends that a geotechnical analysis be performed to estimate the settlement of levee embankments. To effectively perform the analyses, the subsurface exploration boreholes described in Section 2.4 should be performed. The subsurface exploration should also include the collection of cohesive (clayey) embankment and foundation soil samples to perform consolidation laboratory tests that can be used to evaluate the consolidation characteristics of cohesive soils.

An itemized checklist of FEMA Form FF-FY-21-102 requirements for geotechnical analyses to evaluate settlement is provided in Table 5. The USACE (1990) standards in EM 1110-1-1904 provide guidance for estimating settlement for various soil and embankment configurations using computations based on the theory of elasticity and soil consolidation.

Areas of significant settlement are important with respect to possible levee overtopping in a flood event. Settlement is a naturally occurring phenomenon, due to the consolidation of the levee embankment material and its foundation over time, but anomalous or excessive settlement may be an indication of internal erosion due to seepage taking place in the levee embankment or foundation (USACE, 2006). Therefore, the levee should be inspected periodically to identify any unusual settlements.

Table 5: Summary of FEMA Requirements for Settlement

Requirement No.	FEMA Form FF-FY-21-102 Requirements
7	**Settlement**
a	Has anticipated potential settlement been determined and incorporated into the specified construction elevations to maintain the established freeboard margin?
b	Computed settlement range documented
c	Determined cause of levee crest settlement

2.6 Interior Drainage

Requirement

An analysis must be submitted that identifies the source(s) of interior flooding, the extent of the flooded area, and, if the average depth is greater than one foot, the water-surface elevation(s) of the base flood. This analysis must be based on the joint probability of interior and exterior flooding and the capacity of facilities (such as drainage lines and pumps) for evacuating interior floodwaters.

Findings

As described in Section 2.2 the levee has nine interior drainage structures and six stormwater detention ponds are located along the landside of the levee. None of the structures/stormwater detention ponds are equipped with any type of emergency pumping system. The City may have available pumps for interior drainage removal during flood events, but there is no operational plan for any such pumping specified in the O&M manual. As such, they cannot be included in reducing the interior drainage extents in mapping.

The effective FIRM panels, 08077C0812F and 08077C0816F, show limited interior flooding with elevations ranging from 4,563-ft to 4,568-ft (NAVD88). It appears that there have been several construction projects in the area, since the interior flooding was last studied. These may impact interior flooding, and include:

- New ramps for the US HWY 50, Riverside Parkway interchange
- Modifications to the stormwater detention ponds and botanical gardens, including the increase in embankment slope the retainment with large boulders
- General development of the commercial area protected by the levee

Wood completed a Base Level Engineering (BLE) study for Mesa County in 2019. BLE studies are 2D studies generally used to provide a base level understanding of flood risk and to help determine scope for future studies. BLE studies may be upscaled to approximate or detailed 2D studies for areas of interest. Wood enhanced the Mesa BLE study in this levee area to develop a preliminary estimate of interior drainage and flooding for the base flood. This was accomplished by reducing the size of the model to encompass only the area behind the levee and the natural/manmade watershed that drains to that area and then applying the 1% annual chance rain on grid hydrology to the model. The City's stormwater system was not taken into account in this model based on the assumption that it would be full during a major storm event. One major cross drain under Struthers Avenue was incorporated into the model. Pumping that might take place during a flood event was not considered. For this analysis, the model was run assuming the Colorado River is flowing at its BFE, concurrent to a 100-year storm event impacting the City, consistent with Code of Federal Regulations (CFR) requirements.

Overall results from the preliminary modeling for the interior drainage during the base flood event show an increase in flooding extents compared to the effective mapping. The resulting interior BFEs are similar to the effective BFEs, however the extents have changed likely due to new terrain data and improved methodology. The majority of increases in flooding extents are where water is detained along roadway embankments. Flooding appears to be largely contained to roads and undeveloped areas and likely only impacts three structures. Results are presented in Figure 7. A ready-to-run version of the model is included in the electronic files submitted with this report.

Recommendations

Interior flooding conditions should be studied in greater detail. As stated, this preliminary model did not take into account the stormwater system or any potential pumping. These items as well as other model refinement could have a significant impact on the flooding extents shown. For example, the BFEs shown to the north of Riverside Parkway would equalize with elevations to the south of Riverside Parkway if these areas were hydraulically connected in the model. This would likely reduce elevations to the north of Riverside Parkway and increase elevations to the south.

Overall, based on the data available, it appears that there are a few structures at risk from interior flooding. Developing an operational plan for interior pumping is dependent on City interest. A more detailed study would

need to be performed, updating the hydraulic model to estimate the pumping capacity necessary to reduce interior flood extents to a desired level. Any pumping facilities added to the project would require a USACE 408 permit. The final operational plan for any pumping efforts would need to be clearly documented in the O&M manual, and the hydraulic model used to estimate interior flooding BFEs will need to be accepted by FEMA. The community would need to work closely with the USACE for any such modification.

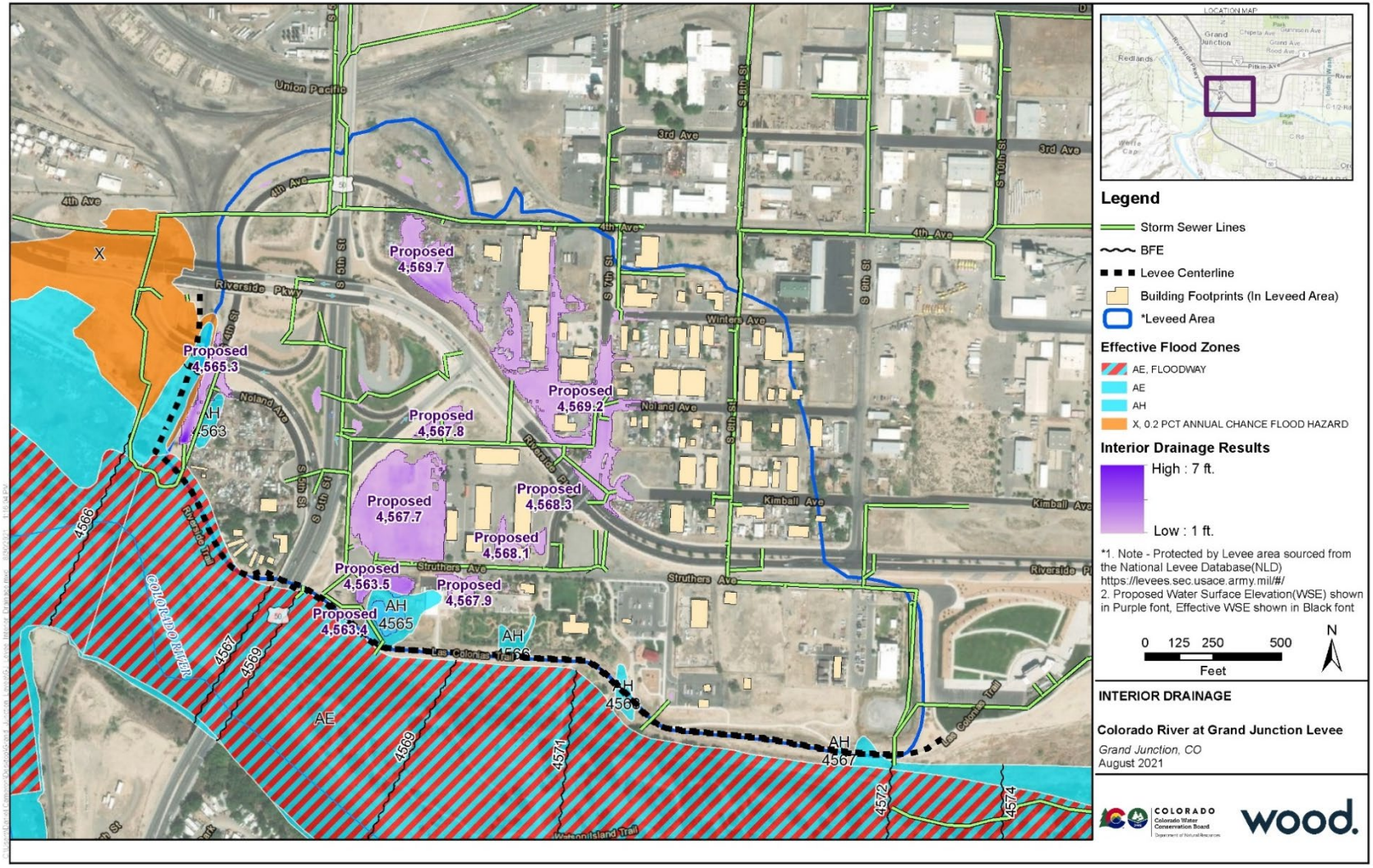

Figure 7: Preliminary Interior Drainage Extents Shown with Effective Flood Zone Data

2.7 Other Design Criteria

In unique situations, such as those where the levee system has relatively high vulnerability, FEMA may require that other design criteria and analyses be submitted to show that the levees provide adequate protection. In such situations, sound engineering practice will be the standard on which FEMA will base its determinations. FEMA will also provide the rationale for requiring this additional information.

The following subsections detail miscellaneous issues found during the field assessment. These issues do not fall under standard design requirements described in 44 CFR 65.10(b), however, it is recommended that these additional design criteria be addressed prior to certification.

2.7.1 Vegetation

Requirement

The USACE has developed standard guidelines for management of vegetation around levees and other similar structures in the report titled, "Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures" (2014). Within this report, the USACE defines the Vegetation-Free Zone, which is a three-dimensional corridor along levees and related structures that must be clear of all vegetation (other than native grasses) and other obstructions to, "assure adequate access by personnel and equipment for surveillance, inspection, maintenance, monitoring, and flood-fighting" (USACE, 2014). A secondary purpose of the Vegetation-Free Zone is that is provides distance between surrounding root systems and the levee. Root systems penetrating the levee can damage the structural integrity of the levee system through piping and seepage issues. Additionally, root systems of trees overturned due to high winds can leave large holes in the surrounding earth, which could also impact the structural integrity of the levee system. The width of the Vegetation-Free Zone is the width of the levee plus an additional 15ft on either side with a minimum height of 8ft, measuring vertically from any point on the ground (USACE, 2014). For areas with appurtenant structures, such as the relief wells, the Vegetation-Free Zone extends 15ft past the structure or to the easement boundary.

Findings

Vegetation was documented within the Vegetation-Free Zone along sections of the levee during the field assessment and through aerial imagery. Approximately 30 percent, of the levee was found to have vegetation within the Vegetation-Free Zone on the landside, riverside, or on both sides of the levee. Most of this vegetation consists of smaller shrubs and brush, however, several trees were also found to be within the Vegetation-Free Zone. Figure 8 summarizes the areas of vegetation along the landside and riverside of the levee and denotes problematic areas of concern where vegetation is found within the Vegetation-Free Zone, which may require tree removal.

Vegetated areas within the Vegetation-Free Zone include parts of the Botanical Gardens and the Butterfly Garden. The Botanical Gardens are located on the landside of the levee centering around stormwater detention pond B. The portion of the Botanical Gardens within the Vegetation-Free Zone that incl shrubs and trees is largely adjacent to high ground. Therefore, most of the trees and large shrubs do not pose a threat to levee integrity. However as noted in Section 2.4, stormwater detention pond B does encroach into the levee prism and therefore vegetation against the levee within proximity of the pond could pose a risk.

The Butterfly Garden is located on the riverside of the levee at approximately levee station 15+00. The garden includes a row of trees approximately 10ft to 20ft away from the toe of the levee. These trees do not likely pose

a risk to levee integrity because they don't impede visibility and physical access for inspections and flood fighting. Additionally, this portion of the levee features inherently stable geometry that is typically wider with a 4.0H:1V landside slope.

Outside of these two areas, there are three additional trees located within the Vegetation-Free Zone. The first tree is located on the riverside of the levee near the access road to Watson Island and is approximately 10ft from the toe of the levee. The second tree is located on the landside of the levee at stormwater detention pond 2. The tree is located on the edge of the levee embankment. The last tree is located on the west side of the Union Pacific Railroad tracks where the levee turns north and follows the railroad embankment. The tree is located on the embankment. Pictures of the trees noted within the Vegetation-Free Zone as well as other vegetation are included in Appendix H.

Recommendations

The most straightforward path to levee certification would be the removal of all vegetation other than native grasses and small weeds within the Vegetation-Free Zone as documented in Figure 8. This will provide for adequate access for inspection and maintenance and would protect against potential root damage. However, it is acknowledged that some of the vegetation within the Vegetation-Free Zone may be important to the community and provide habitat for wildlife.

Another option would be to conduct additional field measurements and analysis for specific areas or plants within the Vegetation-Free Zone to avoid unnecessary removals. Analysis would include evaluating geotechnical conditions that pose a risk to levee integrity (e.g., slope stability and seepage) and analysis by a trained arborist to estimate the current or future extent of any tree root system. Certain tree species for example tend to have more vertical root systems than other trees and may pose less of a risk to the levee integrity. The arborist should also determine if the tree is healthy and stable or should be removed due to the health of the tree and risk imposed to general public or flood fighting personnel.

Wood initially recommends the removal of all large plants on the levee side of stormwater detention pond B, the tree near the Watson Island access, the tree at stormwater detention pond 2, and the tree on the railroad embankment as they are rooted within the levee prism and pose a higher risk. It is initially considered unlikely that the levee would be certifiable without their removal.

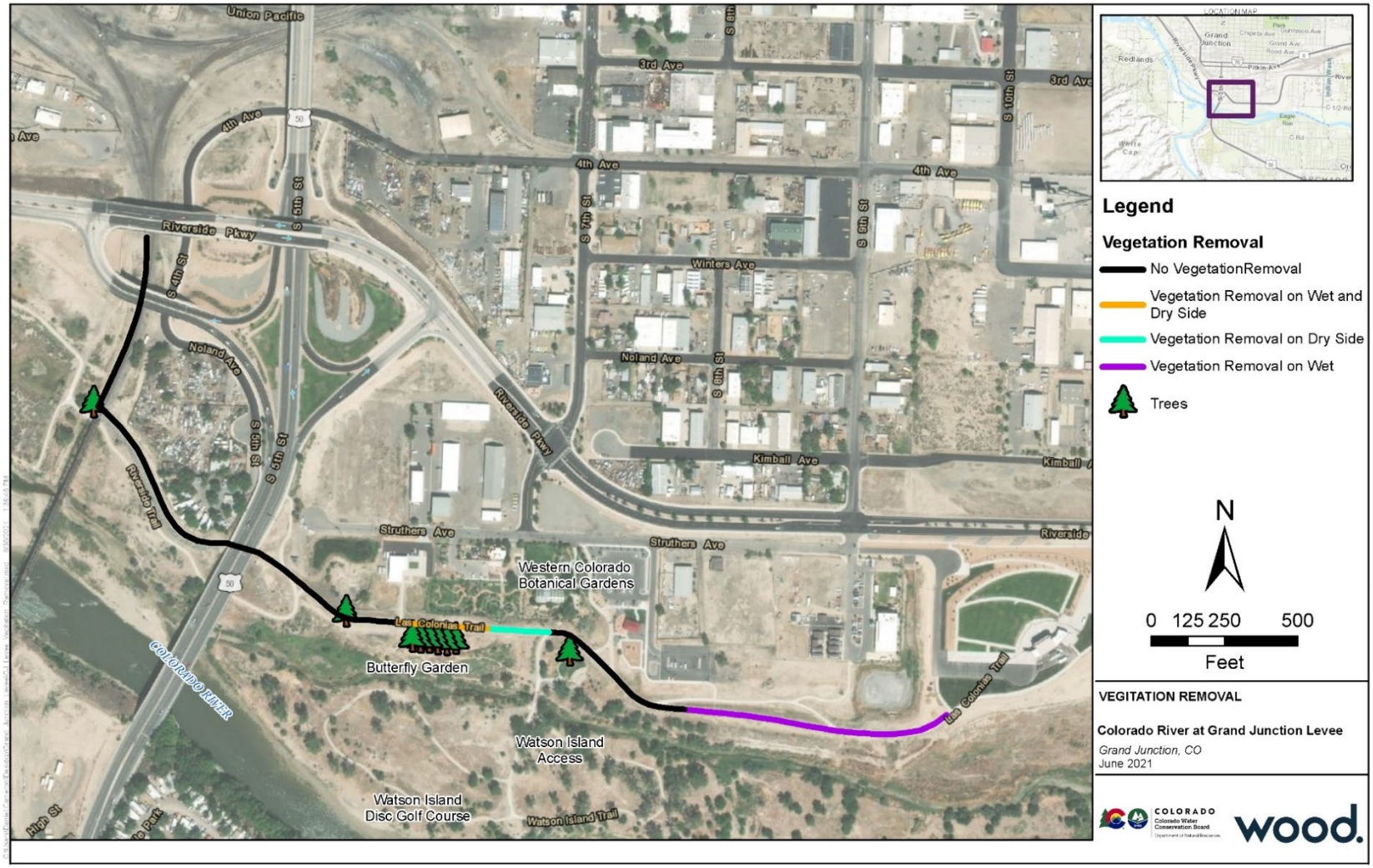

Figure 8: Recommended Vegetation Removal Summary

wood.

2.7.2 Encroachments

Requirement

The primary purpose of the USACE Vegetation-Free Zone is to provide adequate access to levees and other related structures through removing vegetation and other obstructions within the three-dimensional corridor, as discussed in Section 2.7.1. To achieve adequate access and facilitate visual inspections, other non-vegetative encroachments (e.g., fences, buildings, etc.) that could impede maintenance, operations, and flood fighting, or obscure the ground surface, thereby preventing early detection of seepage or scour, must also be considered for removal. Additionally, structures that may compromise the integrity of the levee should not be allowed within the levee prism.

Findings

Several non-vegetative encroachments were documented during the field assessment. Encroachments include three small retaining walls, two small sheds, and a couple of fences. Figure 1 shows the location of the retaining walls and Table 6 summarizes the major encroachments.

The first retaining wall, shown in Figure 9, is located over the outfall for stormwater detention pond 2 and cuts into the levee prism by approximately 2ft. The retaining structure is a simple gravity wall (i.e., utilizes its own weight to retain earth pressures) constructed of concrete masonry unit (CMU) blocks and appears to be in good condition. Since the retaining wall only measures approximately 2ft in height and has a 2H:1V backslope angle, it does not retain a significant amount of soil earth pressure and surcharge loads. Therefore, a wall failure would be unlikely to result in a soil mass collapse that would impact the integrity of the levee or cause a levee breech. Similarly, there is also a small shed, shown in Figure 10, located nearby that has its own small retaining wall also approximately 2ft in height with an approximate backslope angle of 5H:1V. For either case, the gravity retaining walls are located near the levee toe and do not cut significantly into the levee prism. Therefore, the seepage path across the embankment is not significantly shortened.

If the City wishes to certify the levee with these retaining walls, a more detailed geotechnical analysis will be required to confirm that they do not negatively impact the integrity of the levee. Particularly, the extent of the soil wedge supported behind the retaining walls should be assessed and a coupled seepage and stability analyses should be performed to determine if retaining wall failure affects the integrity of the levee.

Figure 9: Retaining Wall and Fence at Stormwater Detention Pond 2

Figure 10: Shed and Retaining Wall at Stormwater Detention Pond 2

An additional 2ft high retaining wall with a 2H:1V backslope, shown in Figure 11, is located over the outfall for stormwater detention pond B and cuts into the levee prism by about 2ft. This structure appears to be a cast-in-place concrete cantilever retaining wall (i.e., footing that holds the wall in position to resist overturning and sliding) and appears to be in good condition. There is also a small shed located nearby. As discussed in Section 2.4, stormwater detention pond B encroaches into the levee prism and the resulting steep slope is stabilized with large boulders. The reduction in levee prism also shortens seepage paths. This area generally will require further geotechnical analysis to evaluate the impact on levee stability and through seepage.

Figure 11: Retaining Wall, Fence, and Shed at Stormwater Detention Pond B (Photo Courtesy of USACE)

The final retaining wall, shown in Figure 12, is located over the outfall for stormwater detention pond C and cuts into the levee prism by approximately 4ft. This wall is constructed of CMU blocks and appears to be in good condition although there is some discoloration apparent on the front of the wall indicating that rainwater may seep through the wall during storm events. The height of this retaining wall and therefore the consequence of potential failure is higher than for the other walls. Failure of this retaining wall has a potential to cause a levee breech as the sliding soil mass (or soil wedge) may likely extend into the levee crest.

Figure 12: Retaining Wall at Stormwater Detention Pond C

In addition to the retaining walls and sheds, there are two fences within the Vegetation-Free Zone. These fences are located around stormwater detention ponds 2 and 2b, as shown in Figures 9 and 10, and stormwater detention pond B, as shown in Figure 11, and restrict access to the head gates for the interior drainage structures that cross the levee at these locations. The fence around stormwater detention pond 2 is barbed wire and does not appear to have an access gate from the levee side. The Fence around stormwater detention pond B is wrought iron and does include an access gate. These fences likely do not pose any geotechnical risk but do hinder inspection and flood fighting efforts along the levee.

Recommendations

As with unsuitable vegetation, encroachments are detrimental to the performance of levees as they restrict access during emergency operations, obscure areas from thorough visual inspections, and may introduce preferred seepage paths. Excavations, structures, or other obstructions present within the levee right-of-way and exclusion zones are generally prohibited (USACE, 2006). The most straight forward path to levee certification would be to remove all encroachments within the levee right of way and exclusion zones however certification may still be possible with further geotechnical analyses if the community prefers to certify with the existing encroachments.

It is Wood's opinion that the existing private chain-link fencing, other small pole structures similar in size to chain-link fencing posts, and small utility encroachments (e.g., utility cable boxes), may be left in place if they do not adversely restrict access to perform emergency operations, maintenance, or inspections. The fence around stormwater detention pond B for example may remain as long as there is a formalized plan, documented in the O&M manual summarizing where keys to the access gate are located in case of necessary access. Such encroachments are typically embedded less than 1ft to provide adequate lateral and overturning resistance and therefore, present minimal risk if post structures overturn or get ripped from the ground, which would result in surficial damage to the slope rather than deep-seated damage that would cause slope instability. Embedment depth for each of these encroachments would need to be satisfactorily demonstrated, and the encroachment approved by the certifying engineer prior to certification.

Wood recommends that other non-vegetative encroachments such as the retaining walls and small shed structures within the Vegetation-Free Zone be considered for removal or relocation prior to certification to provide adequate access to the levee as well as correct the cuts into the levee prism that could lead to levee instability. In contrast with chain-link fence or posts, these structures can obstruct visual evidence of erosion or other potentially unstable conditions. Any voids associated with the removal of the retaining walls and shed structures, including their foundations, should be backfilled and compacted in 6-inch lifts with similar levee materials in consultation with the certifying engineer. Levee certification may be possible with further geotechnical analyses if the community prefers to keep the smaller retaining walls and sheds, however it is unlikely that the levee will be certifiable without the removal of the retaining wall at stormwater detention pond C.

The small retaining walls do not retain a significant soil mass and therefore their failure is unlikely to result in levee failure or to have other detrimental consequences to levee stability. Further geotechnical analysis would be required to prove that this is the case. Failure of the larger retaining wall could lead to levee failure and therefore geotechnical analysis would need to prove that the wall is an engineered part of the levee capable of withstanding the 100yr event. From initial inspection the wall does not appear to be an engineered design and therefore is likely unacceptable.

Any encroachments that the City wishes to maintain will need to be permitted through USACE so that their future maintenance can be monitored and any modifications restricted. The City should also restrict any future encroachments or unauthorized activities within the levee right-of-way unless the City has reviewed and determined to that these encroachments and activities will not impact the levee systems' performance and has received authorization from the USACE District Engineer as required in the O&M manual.

Table 6: Major Encroachments

Current Conditions								Action
Station	Type of Encroachment	Description	Approx. Length cut into Levee Prism (ft)	Approx. Height cut into Levee Prism (ft)	Material	Condition	Notes	
11+61.00	Wall / Fence	Retaining wall located at outlet for stormwater detention pond 2 (C2-261-902).	25	2	CMU Blocks	Good	Wall cuts approximately 2-ft into levee prism. Not in as-builts, no USACE permit. Access restricted by barb wire fence.	Recommend remove wall, repair levee, and extend pipe. Provide access to interior drainage headgate.
12+33.00	Shed / Wall	Shed with small retaining wall located near stormwater detention pond 2 (C2-261-902).	N/A	N/A	CMU Blocks	Good	Wall does not cut into levee prism, but is within 15-ft of levee toe	Likely not an issue, will need to analyze further.
18+55.00	Wall / Fence	Retaining wall located at outlet for stormwater detention pond B (Botanical Gardens).	20	2	Concrete	Unknown	Wall cuts approximately 2-ft into levee prism. Not in as-builts, no USACE permit. Iron fence restricting access, gate with lock.	Area generally needs further geotechnical investigation. Provide access plan for interior drainage headgate in O&M manual.
18+70.00	Shed	Small shed located near stormwater detention pond B (Botanical Gardens).	12	1	Rocks	Unknown	Wall appears to cut slightly into levee prism. Not in as-builts, no USACE permit.	Area generally needs further geotechnical investigation due to steep slope supported by boulders.
22+15.00	Wall	Retaining wall located at outlet for stormwater detention pond C (C2-262-902).	70	4	CMU Blocks	Appears to be seepage through wall	Wall cuts approximately 4-ft into levee prism. Not in as-builts, no USACE permit.	Recommend remove wall, repair levee, and extend pipe. Levee unlikely to be certifiable with this encroachment.

2.7.3 Property Ownership

Requirement

All operation and maintenance activities of levee systems must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP as described in 44 CFR 65.10(c) and (d).

Findings

The City's ArcGIS Online Parcel Map was accessed to view ownership around the levee (link provided in Section 7.0). The City of Grand Junction Parcel Map shows that the levee and the property around the levee upstream of US HWY 50 is owned by the City. Downstream of US HWY 50, there are some gaps in the available parcel information, however this area should be US HWY 50 and Union Pacific Railroad right of way. Every parcel along the levee with parcel ownership information is shown as owned by the City.

Recommendations

Assuming that the City has established access along the US HWY 50 and Union Pacific Railroad right of way, property ownership is not an issue for this levee certification. Ownership and easement status should be verified.

2.7.4 Utilities

Requirement

Utility penetrations through the levee can pose a risk to the structural integrity of the levee by creating potential seepage paths for flood waters and cause instability, erosion, or piping that could impact the levee. They should be evaluated to ensure seepage will not damage the levee prior to certification.

Findings

Several utility penetrations were documented in either the as-built plans, on the City of Grand Junction ArcGIS Online site, or in the 2019 USACE levee inspection report. Table 7 summarizes the location of these utilities and their characteristics, if known.

Table 7: Levee Utility Penetrations

As-Built Station	Source	Utility Type	Size (inches)	Material	Notes	Action
0+.00	City of Grand Junction GIS	Sanitary Sewer	30	RCP		Verify existence/condition
0+.00	City of Grand Junction GIS	Combined Sewer	21	CIPP		Verify existence/condition
0+92.00	USACE 1997, page C-7	Sanitary Sewer	12	Unknown		Verify existence/condition
0+98.00	USACE 1997, page C-7	Sanitary Sewer	14	DIP		Verify existence/condition
7+20.00	USACE 1997, page C-7	Gas Line	10	Steel		Verify condition
8+00.00	USACE 1997, page C-7	Electric	2 – 6"	Steel		Verify condition
8+00.00	USACE 1997, page C-7	Water	24	Steel		Verify condition
8+10.00	City of Grand Junction GIS	Sanitary Sewer	8	PVC		Verify condition
19+44.00	USACE 1997, page C-8	Water	24	Steel		Verify condition
21+50.00	USACE 2019, page 8 of 29	Unknown	4	PVC	Projecting from embankment mid slope. Pipe has been fully grouted	Verify condition and method of grouting
30+75.00	USACE 1997, page C-9	Water	24	Steel	Encased in 36" RCP	Verify existence/condition

Recommendations

The existence and condition in relation to seepage of utilities penetrating the levee summarized in Table 7. The action column indicates what will need to be determined prior to certification. A more complete search for other crossing utilities should also be completed.

3.0 Operation Plan

For a levee system to be recognized, the operational criteria must be as described below. All closure devices or mechanical systems for internal drainage, whether manual or automatic, must be operated in accordance with an officially adopted operation manual, a copy of which must be provided to FEMA by the operator when levee or drainage system recognition is being sought or when the manual for a previously recognized system is revised in any manner. All operations must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP. The following requirements must be met as described in 44 CFR 65.10(c).

- 65.10(c)(1): Closures
- 65.10(b)(2): Interior Drainage Plan

Findings

The O&M for the levee was written by the USACE. It covers levee operation, maintenance, flood fighting, and local cooperation. The manual is officially adopted, and the local sponsor (levee owner) is the City of Grand Junction. Many of the responsibilities for levee maintenance and operation fall under the jurisdiction of the designated levee superintendent. The levee superintendent is appointed by the City of Grand Junction and is responsible for training additional personnel.

Recommendations

The existing O&M manual meets the requirements for being officially adopted, and under the jurisdiction of a community participating in the NFIP.

3.1 Closures

The operation plans for closures must include the following, as described in Section 65.10(c)(1) of the NFIP Regulations.

3.1.1 Flood Warning System

Requirement

Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials that will be used to trigger emergency operation activities; and demonstration that sufficient flood warning time exists for the completed operation of all closure structures, including necessary sealing, before floodwaters reach the base of the closure.

Findings

The existing O&M manual does not state any formal flood warning system and there is no documentation demonstrating sufficient flood warning time for the completed operation of all closure structures. On page 16 the manual states *"When the water surface elevation of the river reaches a height which is equal to or greater than the elevation of the bottom of the flap gate opening, the slide gate should be manually closed."* There is no stated flowrate or stage along the Colorado River that would trigger the start of flood fighting activities. The manual states "immediately upon the receipt of information that high water is imminent" but does not state the information source, or the flowrate or stage at which activities should start.

Recommendations

The O&M manual should be updated to formalize the Flood Warning System to give specifics for stream discharges or stages when levee patrolling should begin, the gage that will be used to monitor this information, and the person responsible for monitoring this gage during flood events (see 3.1.2 for more information on chain of command). The results of the new hydrologic and hydraulic analysis of the Colorado River can help determine the stream discharges or stages when these actions should occur. The stream discharge or stage selected and stated in the revised O&M manual should provide enough time for the responsible individual(s) to close the slide gates without allowing adverse impact due to backwater through the interior drainage structure or to the levee itself. This should be documented in the O&M manual by estimating the time required from when the responsible individual(s) is (are) notified by the Flood Warning System to when they are able to close the slide gates and comparing that against the estimated time it would take for adverse impacts to occur from not closing the slide gates. Note that any modifications to the O&M manual will have to be completed with USACE involvement.

3.1.2 Plan of Operation

Requirement

A formal plan of operation including specific actions and assignments of responsibility by individual name or title must be documented.

Findings

There are no formal assignments of responsibility by individual name or title in the current O&M manual. Section 4-09 simply states that "*The local sponsor is responsible for opening and closing the slide gates*" The O&M manual describes closure maintenance and inspection activities but does not describe their operation other than "*When the water surface elevation of the river reaches a height which is equal to or greater than the elevation of the bottom of the flap gate opening, the slide gate should be manually closed*." The manual also does not include a list of all of the closure structures and corresponding locations that should be operated in a flood event.

Recommendations

An addendum to the O&M manual is recommended to specify individual responsibilities, assignments, and chain of command triggered by the Flood Warning System during a flooding event. It is also recommended that the O&M manual be adapted to list all of the interior drainage structures and separate specific actions for those drainage structures. The slide gate manufacturer manual information should also be included in the O&M manual for reference on proper operation of the gates.

3.1.3 Periodic Operation of Closures

Requirement

Provisions for periodic operation of the closure structure for testing and training purposes, at not less than one-year intervals.

Findings

Sections 4-07 and 4-08 of the O&M manual detail flap gate and slide gate maintenance. The manual specifics that maintenance should occur at least twice a year, before and after each flood season, and include examination, lubrication, and trial operation of all structures. Any damage or maintenance issues discovered should be corrected in a timely manner.

Recommendations

It is recommended that the O&M manual be updated to list all flap gates and slide gates.

3.2 Interior Drainage Plan

Interior drainage systems associated with levee systems usually include storage areas, gravity outlets, pumping stations, or a combination thereof. These drainage systems will be recognized by FEMA on NFIP maps for flood protection purposes only if the following minimum criteria are included in the operation plan. The following requirements must be met as described in 44 CFR 65.10(c)(2).

3.2.1 Flood Warning System

Requirement

Documentation of the flood warning system, under the jurisdiction of Federal, State, or community officials that will be used to trigger emergency operation activities; and demonstration that sufficient flood warning time exists to permit activation of mechanized portions of the drainage system.

Findings

The existing O&M manual does not state any formal flood warning system and there is no documentation demonstrating sufficient flood warning time for the mobilization of a flood fighting effort. The manual states "immediately upon the receipt of information that high water is imminent" but does not state where that information is obtained from or the stream discharge or stage at which activities should start. The internal drainage structures are discussed in Section 3.1.1 and the internal drainage system for this levee does not currently have any pumps that would need to be activated.

Recommendations

The O&M manual should be updated to formalize the Flood Warning System as described in Section 3.1.1. If results from the final interior drainage analysis show interior drainage conditions such that the City chooses to install pumps to mitigate interior flooding, the stream discharge or stage selected and stated in the revised O&M manual should provide enough time for the responsible individual(s) to commence pumping activities. This should be documented in the O&M manual by estimating the time required from when the responsible individual(s) is(are) notified by the Flood Warning System to when they are able to commence pumping and comparing that against the estimated time it would take for adverse impacts to occur from not activating the pumps. (See Section 3.2.2 for additional information that would be needed for pumps).

3.2.2 Plan of Operation

Requirement

A formal plan of operation including specific actions and assignments of responsibility by individual name or title must be provided.

Findings

There are no formal assignments of responsibility by individual name or title in the existing O&M manual as described in Section 3.1.2.

Recommendations

As stated in Section 3.1.2, the O&M manual should include the following: an addendum to the O&M to specify individual responsibilities, assignments, and chain of command during a flooding event, interior drainage structures, the slide gate manufacturer manual information. In addition, if pumps are determined to be necessary, the manual should include specific locations of pumps, and information on how pumps should be transported and placed for each interior drainage structure. Additionally, if a pumping plan is pursued this will require a USACE 408 permit and coordination with the USACE.

3.2.3 Manual Backup

Requirement

Provision for manual backup for the activation of automatic systems must be in place.

Findings

There are no automatic systems that are part of the interior drainage system.

Recommendations

Since there are no automatic systems that are part of the interior drainage system, no manual backup is required. Should automatic systems ever be installed, the City in partnership with the USACE would be responsible for updating the O&M manual to include this information.

3.2.4 Periodic Inspection

Requirement

Provisions for periodic inspection of interior drainage systems and periodic operation of any mechanized portions for testing and training purposes. No more than 1 year shall elapse between either the inspections or the operations.

Findings

As described in Section 3.1.3, the O&M manual specifies required maintenance activities for flap gates and slide gates. Maintenance should occur at least twice a year, before and after each flood season, and include examination, lubrication, and trial operation of all structures. Any damage or maintenance issues discovered should be corrected in a timely manner. There are no pumps or automatic systems to inspect or test.

Sections 4-07 and 4-08 of the levee O&M manual also states that special attention be paid to the following items:

- Gate alignment and seating
- Pivots shall be free of stiff or binding action
- Debris or obstructions inhibiting full closure
- Trash or sediment that might obstruct gates or flow of water
- Damage
- Excessive vegetation
- Corrosion

Recommendations

As stated in 3.1.3, it is recommended that the O&M manual be updated to include all flap gates and slide gates.

4.0 Maintenance Plan

For levee systems to be recognized as providing protection from the base flood, the maintenance criteria must be as described in 44 CFR 65.10(d).

Requirements

1. Levee systems must be maintained in accordance with an officially adopted maintenance plan, and a copy of this plan must be provided to FEMA by the owner of the levee system when recognition is being sought or when the plan for a previously recognized system is revised in any manner.
2. All maintenance activities must be under the jurisdiction of a Federal or State agency, an agency created by Federal or State law, or an agency of a community participating in the NFIP that must assume ultimate responsibility for maintenance.
3. This plan must document the formal procedure that ensures that the stability, height, and overall integrity of the levee and its associated structures and systems are maintained. At a minimum, the plan shall specify the maintenance activities to be performed, the frequency of their performance, and the person by name or title responsible for their performance.

Findings

Section 3 of the O&M manual covers levee management and inspection, while Section 4 covers operation and maintenance. These sections together cover the levee maintenance plan. Most of the requirements in Section 3 fall under the jurisdiction of the appointed levee superintendent. The requirements presented in Section 4 are split between the City and the levee superintendent.

Specified levee maintenance activities include:

- Inspections, reporting, and record keeping
- Correcting settlement, sloughing, or material loss
- Monitoring and correcting erosion issues
- Maintaining service/patrol roads
- Correcting seepage and sand boil issues
- Maintaining drainage structures
- Maintaining riprap
- Monitoring for unpermitted encroachments
- Addressing burrowing animal issues
- Maintaining vegetation
- Channel maintenance
- Flap and slide gate maintenance
- Relief well inspection and maintenance

The plan does specify the maintenance activities that are to be performed and the frequency of their performance. However, it does not include any formal assignments of responsibility by individual name or title or provide specific locations where maintenance activities should be performed, if applicable.

Recommendations

The O&M manual should be more specific about the locations for required maintenance. The manual should also include an addendum to specify individual responsibilities related to these routine maintenance activities. It

is also recommended that the updated manual be re-organized such that all maintenance activities are listed under the maintenance section of the manual.

5.0 Certification Requirements

To obtain FEMA accreditation of the levee, data must be submitted to support that a given levee system complies with the structural requirements and must be certified by a registered professional engineer as described in 44 CFR 65.10(e). Also, certified as-built plans of the levee must be submitted.

Findings

As-built plans from the original levee construction exist. However, recent modifications to the levee do not appear in the as-built data. Modifications not appearing in the as-builts include:

- Two interior drainage structures associated with stormwater detention pond 3
- Three retaining walls within the levee embankment
- Modifications to the levee embankment at stormwater detention pond B

Additionally, the as-built levee profile does not match the levee crest elevations from the 2017 survey of the levee. It appears that the levee design was modified during construction, and it is necessary to consult multiple sheets to obtain a complete picture of the as-built conditions for any section of the levee. The drawings also present conflicting information as to pipe locations and diameters in a few places and there is no reference to the relief well locations. Overall, it is Wood's opinion that modifying the existing as-built plans to reflect current levee conditions is not adequate and might result in confusion during emergency operations.

Recommendations

It is recommended that updated as-built data be developed for the levee to reflect current conditions, especially where any levee improvements will (or have been) be made, and for any encroachments that the City wishes to retain. Additionally, certified as-built plans of the levee will need to be produced and submitted with the engineer's certification package once the levee documentation is submitted for FEMA accreditation.

6.0 Summary

The levee overall is well maintained and is in good condition. However, there are several items that may prevent the levee from achieving levee certification in its current condition. The recommended actions and additional analyses contained in this report are necessary to determine final levee compliance based on the requirements of 44 CFR 65.10. Depending on the findings of these additional analyses and efforts, modifications to the levee may be required to achieve levee certification under the requirements of 44 CFR 65.10.

The following table summarizes all levee accreditation requirements, the current levee condition, and recommendations prior to submitting for FEMA levee accreditation.

Table 8: FEMA Levee Accreditation Requirements

CFR Section	Requirements	Acceptable	Needs Additional Data	Unacceptable	Comments / Exceptions
65.10(b)(1) - Freeboard	Has 3 feet of freeboard	x			
65.10(b)(1) - Freeboard	Has 4 feet of freeboard wherever flow is restricted			x	Freeboard Requirement not met upstream of the railroad crossing
65.10(b)(1) - Freeboard	Has 3.5 feet of freeboard at upstream end of levee	x			
65.10(b)(2) - Closures	All openings are provided with closure devices that are structural parts of the system during operation and are designed according to sound engineering practice.	x			
65.10(b)(3) - Embankment Protection	Analyses demonstrate that no appreciable levee erosion can be expected during base flood event.		x		Although preliminary analysis shows that embankment protection is adequate, further investigation into geomorphology of site is recommended.
65.10(b)(3) - Embankment Protection	Anticipated erosion for base flood is not anticipated to result in failure of levee embankment or foundation.	x			
65.10(b)(4) - Embankment and Foundation Stability	Analysis indicates anticipated seepage into or through the levee during loading conditions associated with the base flood will not jeopardize embankment or foundation stability.		x		Unlikely that there will be embankment stability and seepage issues however geotechnical investigation required to meet requirements of FEMA Riverine Structures Form 3.
65.10(b)(5) - Embankment Settlement	Analysis indicates that anticipated future settlement will not result in a loss of freeboard per section (b)(1) of 65.10.		x		Unlikely that there will be settlement issues. However, further geotechnical investigation is required to meet requirements of FEMA Riverine Structures Form 3.

CFR Section	Requirements	Acceptable	Needs Additional Data	Unacceptable	Comments / Exceptions
65.10(b)(6) - Interior Drainage	Analysis has been developed and submitted identifying the sources of such flooding, the extent of the flooded area, and the water surface elevations. This analysis is based upon the joint probability of the interior and exterior.		x		Interior drainage model should be updated to account for stormwater system.
65.10(b)(7) - Other Design Criteria					
65.10(c)(1) - Operation/Closures	O&M manual includes documentation of an adequate flood warning system that provides a sufficient warning time to operate all closure structures.			x	O&M manual needs to include a flood warning system. Coordinate with USACE.
65.10(c)(1) - Operation/Closures	O&M manual contains a formal operations plan, including specific actions and assignments of responsibility by name or title.			x	O&M manual needs assignments of responsibility. Coordinate with USACE.
65.10(c)(1) - Operation/Closures	O&M manual requires periodic operation of closures at not less than one-year intervals.	x			
65.10(c)(2) - Operation/Interior Drainage Systems	O&M manual includes documentation of an adequate flood warning system that provides a sufficient warning time to operate all mechanized portions of the interior drainage system.			x	O&M manual needs to include a flood warning system. Coordinate with USACE.
65.10(c)(2) - Operation/Interior Drainage Systems	O&M manual contains a formal operations plan, including specific actions and assignments of responsibility by name or title.			x	O&M manual needs assignments of responsibility. Coordinate with USACE.
65.10(c)(2) - Operation/Interior Drainage Systems	O&M manual includes provisions for manual backup for activation of automatic systems.	x			No automatic systems
65.10(c)(2) - Operation/Interior Drainage Systems	O&M manual contains provisions for periodic inspection of interior drainage systems a minimum of annually.	x			
65.10(d) - Maintenance plans and criteria	Maintenance plan is an officially adopted maintenance plan.	x			

CFR Section	Requirements	Acceptable	Needs Additional Data	Unacceptable	Comments / Exceptions
65.10(d) - Maintenance plans and criteria	Maintenance plan includes provision that all maintenance activities must be performed under appropriate jurisdiction.	x			
65.10(d) - Maintenance plans and criteria	Maintenance plan documents formal procedure that ensures stability, height, and overall integrity of the levee system are maintained (includes specification of activities to be performed, their frequency, and person by name or title that is responsible.		x		Maintenance plan should be updated and re-organized. Coordinate with USACE.
65.10(e) - As-Built Drawings	As-built drawings of the levee system must be submitted as part of the certification package.			x	As-built plans need to be updated to reflect current conditions. Coordinate with USACE.

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APPENDIX A – AS-BUILT DRAWINGS

APPENDIX B – EFFECTIVE FEMA PRODUCTS

APPENDIX C- PRELIMINARY FREEBOARD ANALYSIS

APPENDIX D – PRELIMINARY EMBANKMENT PROTECTION ANALYSIS

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APPENDIX B

Base Level Engineering Report

Mesa County, Colorado
Project #32790120 | Colorado Water Conservation Board

Prepared for:

Colorado Water Conservation Board
1313 Sherman Street, Room 718, Denver, CO 80203

10/17/2019

Base Level Engineering Report

Mesa County, Colorado
Project #32790120 | Colorado Water Conservation Board

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1313 Sherman Street, Room 718, Denver, CO 80203

Prepared by:

Wood Environment and Infrastructure Solutions

10/17/2019

Base Level Engineering Report Overview

Wood Environment and Infrastructure Solutions, Inc. (Wood) has been engaged by the Colorado Water Conservation Board (CWCB) to provide technical support and consultation for the Colorado Risk Mapping, Assessment and Planning (Risk MAP) program. The Risk MAP program is designed to deliver quality data, increase public awareness of flood risk, and encourage local/regional actions that reduce risk by working with stakeholders. The Discovery phase of the Risk MAP program is an integral process that provides for the exchange of information between local, state, federal, and private-sector stakeholders. Mesa County Discovery was funded by the CWCB and wood has compiled findings from the Discovery process in the 2019 document, *Discovery Report, Mesa County, CO*.

As part of the Discovery process in Mesa County, CO, Wood investigated the flood risk potential for the County through development and application of large-scale Base Level Engineering (BLE). Results from the BLE analysis are intended to inform and aid the County in future decisions related to flood risk. This report summarizes the methodologies and results of the BLE analysis and though it is a stand-alone document, is intended to complement the 2019 *Discovery Report*.

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List of Acronyms

2D	Two Dimensional
BLE	Base Level Engineering
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
CID	Community Identification
CN	Curve Number
CWCB	Colorado Water Conservation Board
DEM	Digital Elevation Model
DNR	Department of Natural Resources
DSS	Data Storage System
FEMA	Federal Emergency Management Agency
HEC-RAS	Hydrologic Engineering Center Riverine Analysis System
HEC-SSP	Hydrologic Engineering Center Statistical Software Package
HUC	Hydrologic Unit Code
IFSAR	Interferometric Synthetic Aperture Radar
LiDAR	Light Detection and Ranging Data
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Association
NRCS	Natural Resources Conservation Service
PFDS	Precipitation Frequency Data Server
QL	Quality Level
Risk MAP	Risk Mapping, Assessment and Planning
SCS	Soil Conservation Service
SEP	Standard Error of Prediction
SSURGO	Soil Survey Geographic Database
TR-55	Technical Release 55
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geologic Survey
Wood	Wood Environment and Infrastructure Solutions, Inc.
WRIR	Water Resources Investigations Report

1.0 Background Information

Mesa County is approximately 3,350 square miles and is located in western Colorado along the Colorado-Utah Stateline. There are three major river that flow through the county, including the Colorado River, the Dolores River, and the Gunnison River. The topography in the region is very diverse, and includes high elevation mesas, mountainous terrain, and flat valleys. The predominant land cover types in the county are agricultural fields, desert shrubs, pinon-juniper trees, and other forested lands. Figure 1 provides an overview of Mesa County, showing the location of the communities within the county, the three major rivers, and the HUC-8 Watersheds that cover the county.

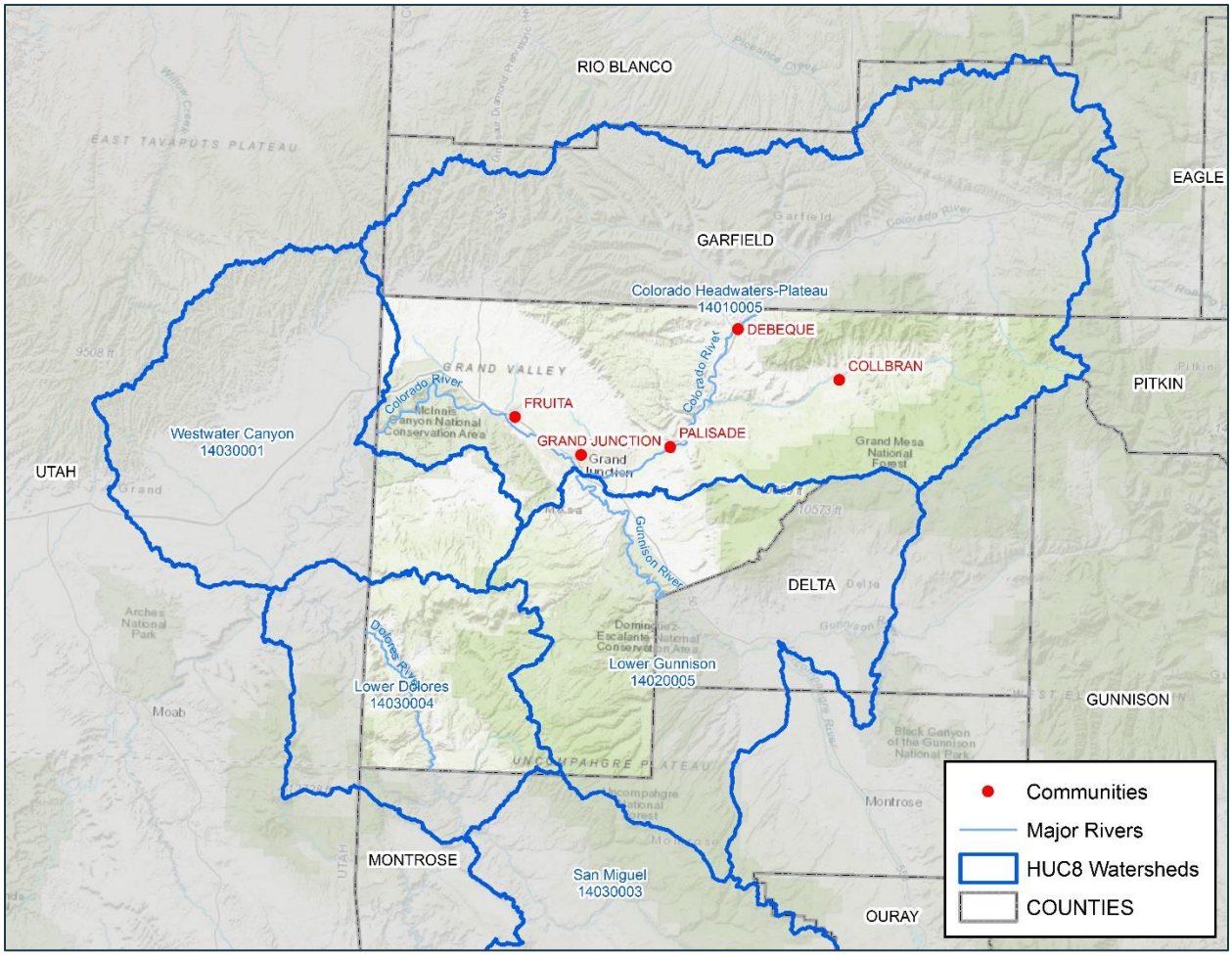

Figure 1: Project Overview Map

2.0 Base Level Engineering

As part of this Discovery process in Mesa County, a two-dimensional (2D) Base Level Engineering (BLE) analysis in the USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) Version 5.0.6 was performed. BLE provides flood risk information at large scales that can be shared with governing officials to make informed decisions regarding flooding for areas that lack or have outdated flood risk information. BLE differs from typical FEMA flood risk products because it often applies engineering methodologies at large scales (i.e. watershed), as opposed to communities or specific reaches of stream. BLE data is used as best available information for unmapped areas and areas designated as Zone A floodplain (BLE Guidance).

The following sections detail the 2D BLE model development for Mesa County.

2.1 Topographic Data

Several topographic datasets were used as part of this analysis. The primary topographic data used was 0.7-meter resolution LiDAR data. This data meets FEMA standards (QL2) and was gathered in 2015 and 2016 by Woolpert, Inc. The LiDAR data covers all of Mesa County and all analysis and mapping within the county boundaries utilized this topography source. A combination of other LiDAR and Interferometric Synthetic Aperture Radar (IFSAR) datasets and 10-meter digital elevation model (DEM) datasets were used to supplement areas of contributing drainage areas outside of the Mesa County LiDAR extents. Table 1 summarizes all the topographic datasets used for this analysis and Figure 2 depicts the coverage of each dataset.

Table 1: Summary of Topographic Datasets

Region	Topographic Dataset	Quality Level	Point Resolution	Year Flown	Flown By	Provided By
Mesa County	Mesa County QL2 LiDAR	QL2	0.7 m	2015-2016	Woolpert, Inc.	CWCB
Delta County	Western Colorado LiDAR	QL2	< 1 m	2015	Quantum	CWCB
Garfield County	Colorado CGS 3DEP	QL2	0.9 m	2016-2017	Merrick & Company, Inc.	CWCB
Montrose County	USACE Colorado IFSAR	QL3+	15 ft	Unknown	InterMap, Inc.	CO-DNR
Utah	USGS 1/3 arc-second (10-meter) DEM	N/A	N/A	Continuous Updates	N/A	N/A

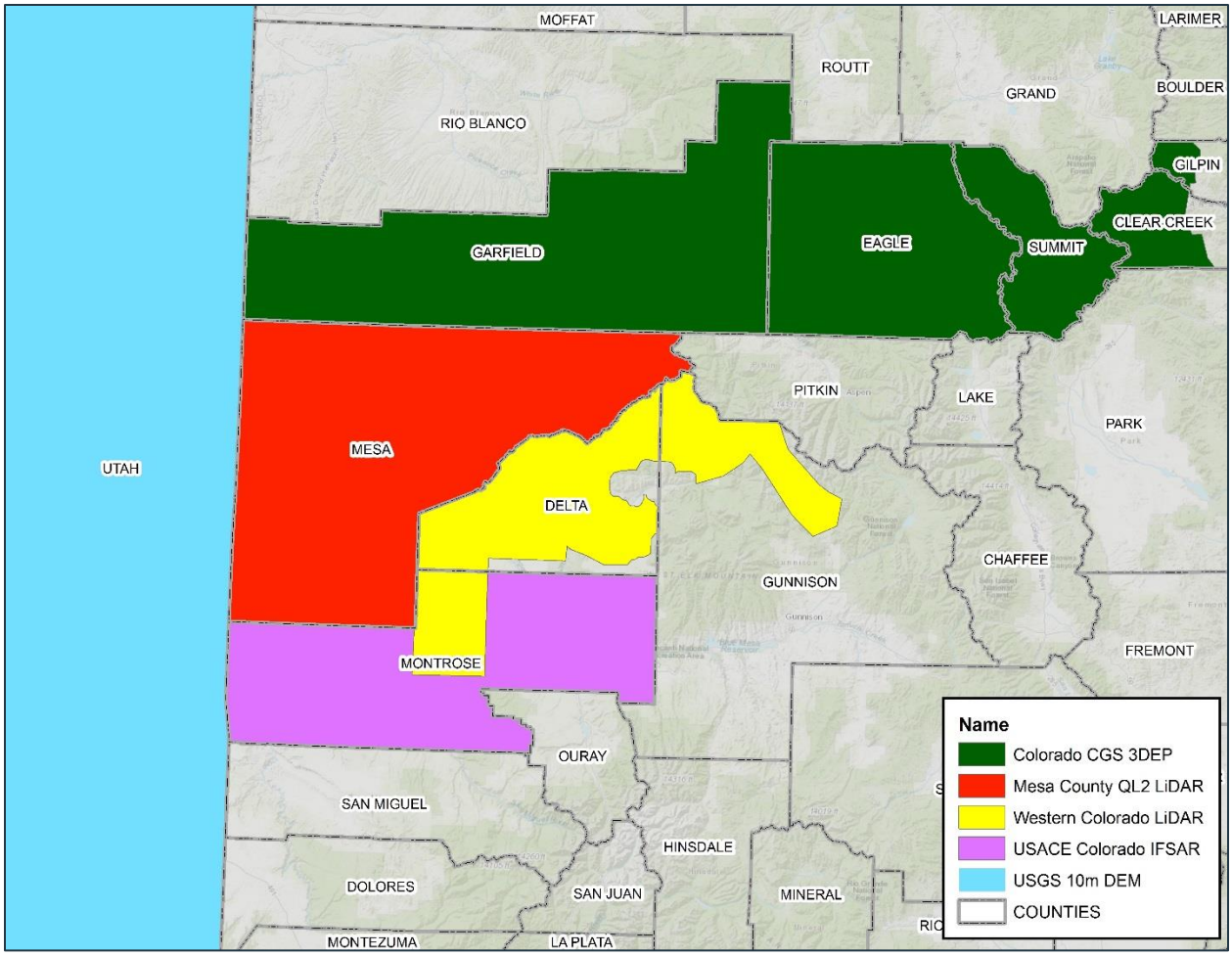

Figure 2: Topographic Dataset Coverage

2.2 Computational Boundaries

Mesa County and select contributing drainage areas outside of the county were divided in to 20 sub-watersheds, or basins. These basin boundaries were determined based on a combination of the Mesa County boundary and HUC-10 and HUC-12 watershed boundaries. The basins range from 61 to 250 square miles (Figure 3). A separate 2D rain-on-grid hydraulic model was developed for each basin and hydrologic parameters were estimated for each basin. The average basin size for this analysis was significantly smaller than a typical 2D BLE basin size to allow for more detail in the hydrologic parameter estimation and hydraulic model development.

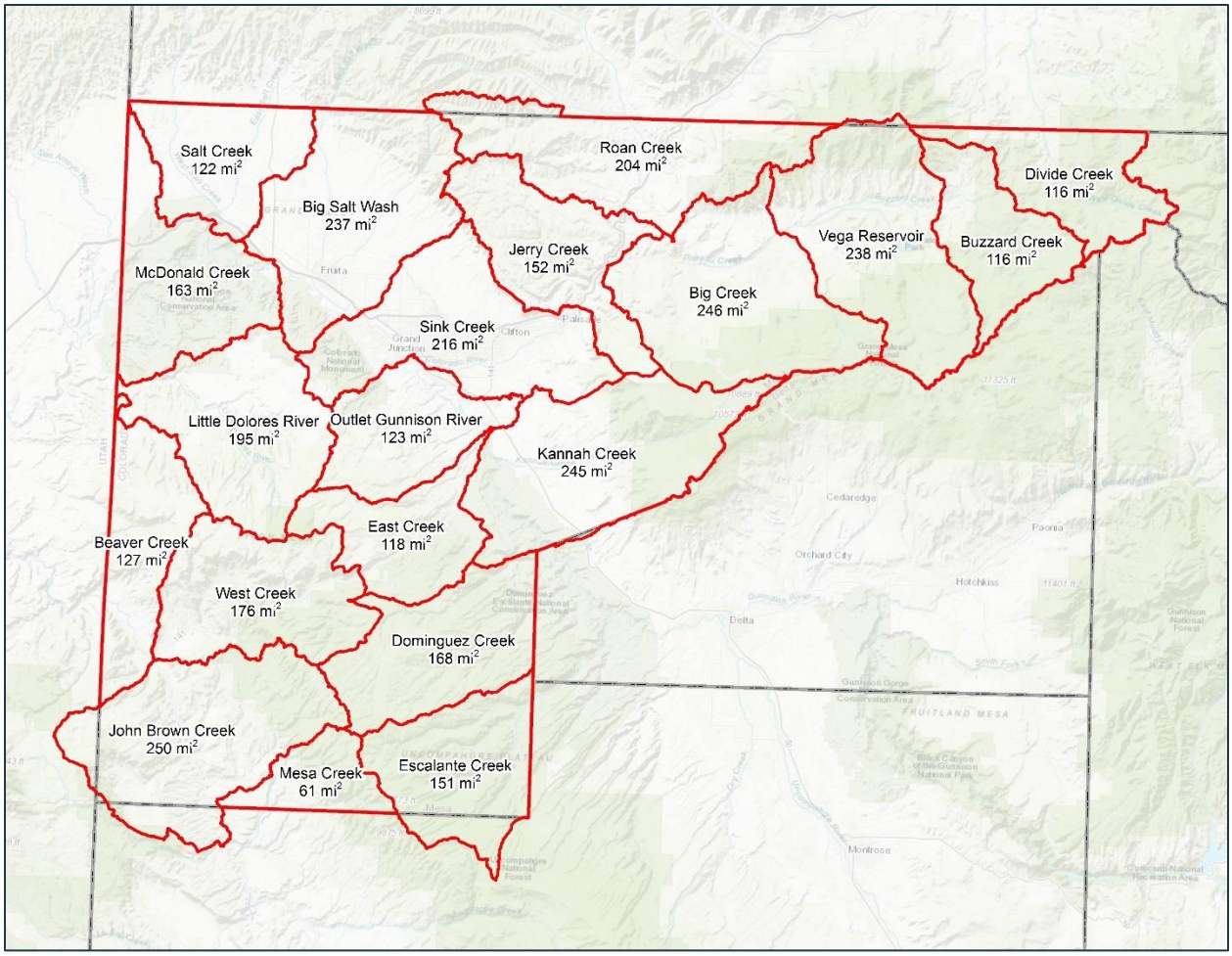

Figure 3: Computational Basin Boundaries

2.3 Hydrologic Analysis

Mesa County is located in Western Colorado along the Colorado-Utah Stateline. The topography of Mesa County varies from high elevation mesas, like the Grand Mesa, to low-lying flat, wide valleys. Three major rivers flow into the county: the Colorado River, the Dolores River, and the Gunnison River.

Mesa County is generally a semi-arid climate, with a larger amount of total precipitation in the higher elevations of the eastern and southern portions of the county compared to the drier central and northern portions of the county.

A rain-on-grid methodology was used for the 2D BLE analysis. This methodology applies precipitation directly to the modeling surface of the resulting runoff through the 2D mesh to perform the hydraulic calculations.

The pre-model development hydrologic analysis of Mesa County included obtaining precipitation data for the entire county and developing inflow hydrographs for the three major rivers flowing into the county. Additionally, hydrographs for several minor streams flowing into the county were leveraged from the Garfield County and Delta County 2D BLE analyses provided by the CWCB.

2.3.1 Precipitation

Precipitation data for the analysis was obtained from the National Oceanic and Atmospheric Association (NOAA) Atlas 14 Precipitation Frequency Data Server (PFDS). Precipitation grid data was downloaded from the PFDS (Volume 8: Midwestern States) for each required recurrence interval and was spatially averaged using ArcGIS Version 10.2.2 for each sub-watershed basin to obtain a single basin average precipitation depth. The NOAA Atlas 14 (Volume 8) - Western Colorado (Region 2) - First Quartile Hyetograph Distribution, shown in Figure 4 as used to temporally distribute the precipitation depths for each recurrence interval.

No areal reduction factors were utilized for this project. This is discussed in more detail in the Calibration section below.

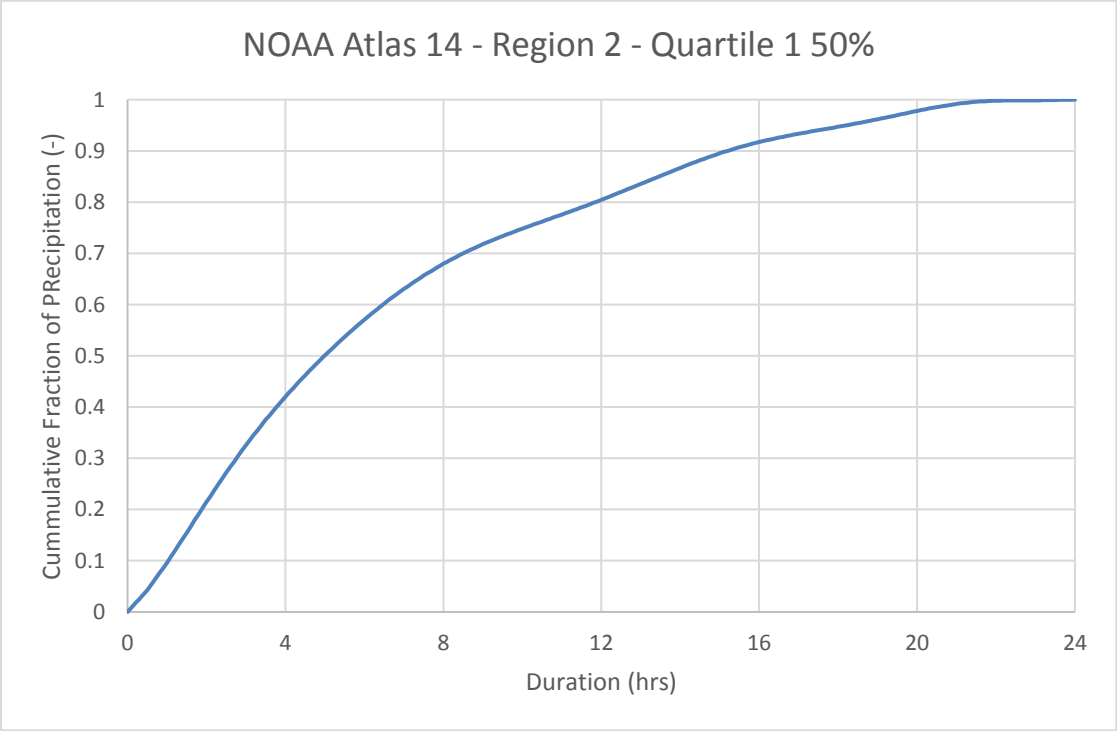

Figure 4: NOAA Atlas 14 (Volume 8) - Western Colorado (Region 2) - First Quartile Hyetograph Distribution

2.3.2 Loss Methodology

The Soil Conservation Service (SCS) Runoff Curve Number (CN) Method was used to estimate the amount of rainfall lost to various physical abstractions and the resulting amount of rainfall that contributes to runoff for each basin. Land cover data and soil data was used to estimate a CN for each basin based on Natural Resources Conservation Service (NRCS) Technical Release 55 (TR-55). National Land Cover Database (NLCD) 2011 data was obtained to define the land cover for Mesa County and NRCS Soil Survey Geographic Database (SSURGO) data was used to define the hydrologic soil group regions for the CN calculations. The CN for each basin was estimated by first spatially intersecting the land cover data and soil data with the basin boundaries and assigning a CN for each spatial element based on its land cover type and hydrologic soil group using the matrices presented in Table 2 and Table 3. A spatial average was then computed for each basin to determine the basin's CN. Separate matrices were used to calculate the CN for the western and eastern portions of the county due to differences in land cover, specifically with the hydrologic condition of the land cover. Figure 5 shows the regional matrix utilized and the resulting estimated CN for each basin.

Table 2: Eastern Land Cover-Hydrologic Soil Group CN Matrix

NLCD Value	Land Cover	TR-55 Equivalent	Soil Condition	Hydrologic Soil Group			
				A	B	C	D
11	Open Water	Impervious Areas	N/A	98	98	98	98
12	Perennial Ice/Snow	Impervious Areas	N/A	98	98	98	98
21	Developed, Open Space	Open Space	Fair	49	69	79	84
22	Developed, Low Intensity	Residential District (1/4 acre)	N/A	61	75	83	87
23	Developed, Medium Intensity	Residential District (1/8 acre)	N/A	77	85	90	92
24	Developed, High Intensity	Commercial and Business	N/A	89	92	94	95
31	Barren Land (Rock/Sand/Clay)	Pasture, grassland, or range	Poor	68	79	86	89
41	Deciduous Forest	Woods	Fair	36	60	73	79
42	Evergreen Forest	Woods	Fair	36	60	73	79
43	Mixed Forest	Woods	Fair	36	60	73	79
52	Shrub/Scrub	Brush	Fair	35	56	70	77
71	Grassland/Herbaceous	Herbaceous	Fair	71	71	81	89
81	Pasture/Hay	Pasture, grassland, or range	Fair	49	69	79	84
82	Cultivated Crops	Row Crops (SR+CR)	Poor	71	80	87	90
90	Woody Wetlands	Woods	Poor	45	66	77	83
95	Emergent Herbaceous Wetlands	Herbaceous	Poor	80	80	87	93

Table 3: Western Land Cover-Hydrologic Soil Group CN Matrix

NLCD Value	Land Cover	TR-55 Equivalent	Soil Condition	Hydrologic Soil Group			
				A	B	C	D
11	Open Water	Impervious Areas	N/A	98	98	98	98
12	Perennial Ice/Snow	Impervious Areas	N/A	98	98	98	98
21	Developed, Open Space	Open Space	Fair	49	69	79	84
22	Developed, Low Intensity	Residential District (1/4 acre)	N/A	61	75	83	87
23	Developed, Medium Intensity	Residential District (1/8 acre)	N/A	77	85	90	92
24	Developed, High Intensity	Commercial and Business	N/A	89	92	94	95
31	Barren Land (Rock/Sand/Clay)	Pasture, grassland, or range	Poor	68	79	86	89
41	Deciduous Forest	Pinyon-juniper	Fair	58	58	73	80
42	Evergreen Forest	Pinyon-juniper	Fair	58	58	73	80
43	Mixed Forest	Pinyon-juniper	Fair	58	58	73	80
52	Shrub/Scrub	Desert Shrub	Poor	63	77	85	88
71	Grassland/Herbaceous	Herbaceous	Fair	71	71	81	89
81	Pasture/Hay	Pasture, grassland, or range	Fair	49	69	79	84
82	Cultivated Crops	Row Crops (SR+CR)	Poor	71	80	87	90
90	Woody Wetlands	Woods	Poor	45	66	77	83
95	Emergent Herbaceous Wetlands	Herbaceous	Poor	80	80	87	93

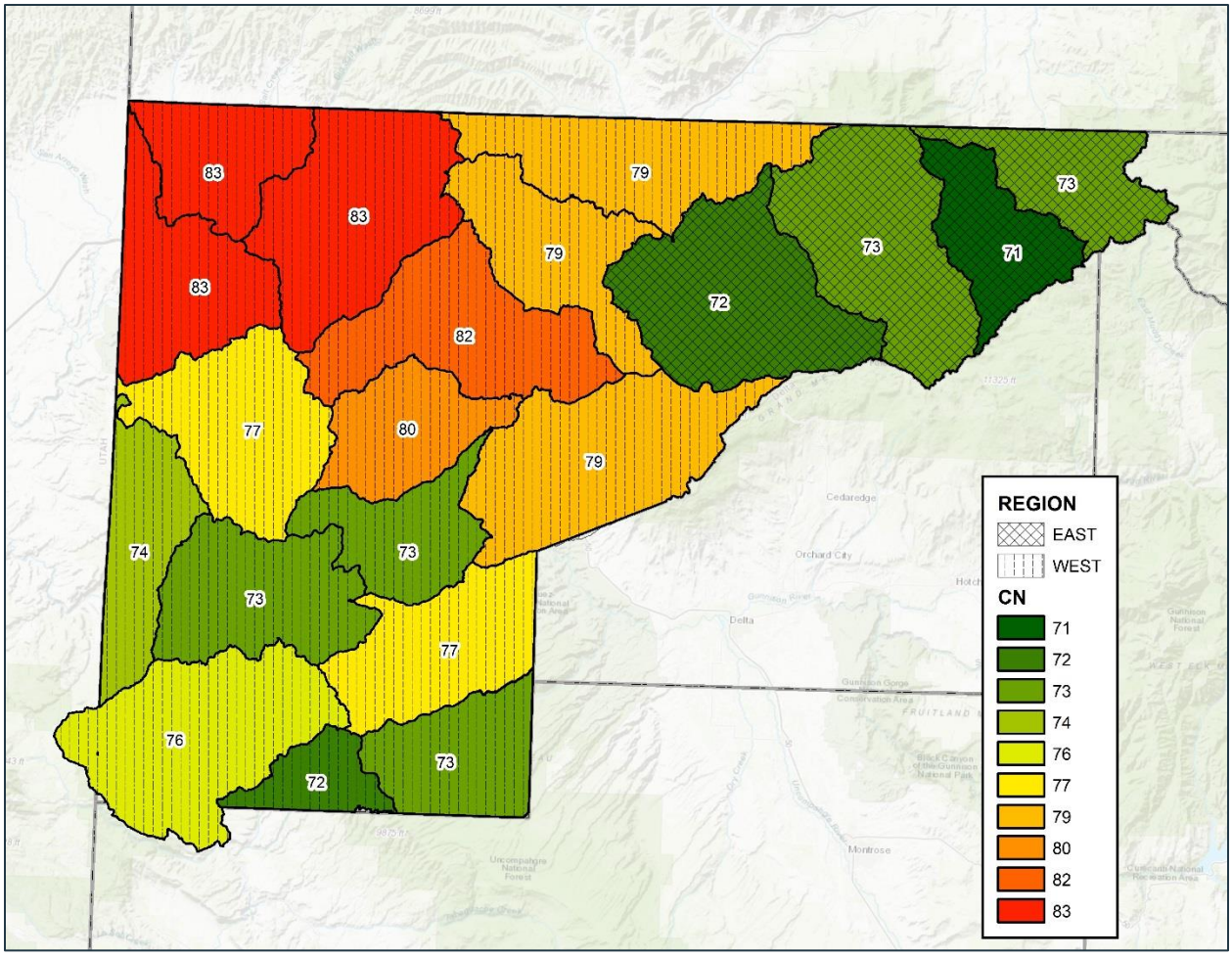

Figure 5: Curve Number Summary

At the time of this analysis, HEC-RAS does not have the capability to model abstraction losses within the model. To account for this, excess rainfall hyetographs were calculated outside of the program in spreadsheets using the SCS Runoff Curve Number equations outlined in TR-55. These excess rainfall hyetographs were then applied to the HEC-RAS models for each basin.

2.3.3 Stream Gage Analyses and Other Inflows

Three major rivers flow into Mesa County: the Colorado River, the Dolores River, and the Gunnison River. Strictly using a rain-on-grid methodology would require modeling the entire watershed for each of these rivers, which would add an additional 18,700 square miles of drainage area. This would increase the modeled drainage area to nearly 5.5 times the size of Mesa County and dramatically increase the complexity and computational demand of the model. Instead, hydrographs were developed for the three rivers based on stream gage data for each recurrence interval and input into the models where the rivers cross into the county.

Historical stream gage data was used to conduct Log Pearson Type III flood frequency analyses using Bulletin 17C methods in the USACE Hydrologic Engineering Center Statistical Software Package (HEC-SSP) Version 2.1.1.137 to determine peak flows for the three major rivers flowing into Mesa County. The Colorado River flood frequency analysis was done as part of the regional Colorado River Hydrologic Evaluation

previously conducted by Wood, which studied the Colorado River from Granby to the Colorado-Utah Stateline (2017).

Several additional stream gages were also analyzed using the same methodology as above for model calibration. Table 4 summarizes the stream gages analyzed for this study and the resulting peak flows.

Hydrograph data was also leveraged from the neighboring Delta and Garfield County BLE studies for smaller drainages flowing into the county. These studies also employed a 2D rain-on-grid methodology and were provided to Wood by the CWCB. Using hydrograph data from these studies reduced the size of the required rain-on-grid study area for the Mesa County while also creating a seamless connection between these neighboring studies.

Table 4: Stream Gage Analysis Summary

USGS Gage ID	Gage Name	Status	Years of Record	Drainage Area (mi^2)	Bulletin 17C Peak Flows (cfs)						
					10%	4%	2%	1% -	1%	1% +	0.2%
09097600	Brush Creek near Collbran, CO.	Inactive	12	9.30	217	321	419	352	537	1,260	911
09097500	Buzzard Creek near Collbran, CO.	Inactive	59	143	1,130	1,390	1,560	1,500	1,720	2,040	2,030
09095500	Colorado River near Cameo, CO	Active	84	7,990	29,600	34,200	37,400	37,800	40,400	44,300	46,800
09106150	Colorado River below Grand Valley Diversion	Active	27	8,750	30,900	38,400	43,800	44,500	49,000	55,400	60,600
09163500	Colorado River near Colorado-Utah State Line	Active	67	17,855	46,900	56,200	68,600	70,500	78,100	89,200	101,000
09180000	Dolores River near Cisco, UT	Active	53	4,570	8,870	11,800	14,300	13,500	16,800	23,500	23,600
09152500	Gunnison River near Grand Junction, CO	Inactive	109	7,930	22,800	27,200	29,900	29,900	32,200	35,800	36,300
09152000	Kannah Creek near Whitewater, CO	Inactive	64	60.8	919	1,130	1,290	1,290	1,450	1,740	1,870
09104500	Mesa Creek near Mesa, CO	Inactive	24	5.33	75.4	105	134	122	169	304	285
09096500	Plateau Creek near Collbran, CO.	Inactive	59	80.4	1,060	1,240	1,380	1,310	1,510	1,940	1,800
09105000	Plateau Creek near Cameo, CO	Inactive	80	592	3,240	4,080	4,690	4,640	5,290	6,180	6,650
09153290	Reed Wash near Mack, CO	Inactive	25	15.8	248	315	374	352	440	662	634
09095000	Roan Creek near DeBeque, CO.	Inactive	22	323	1,230	1,620	1,940	1,900	2,290	2,920	3,200
09089500	West Divide Creek near Raven, CO.	Inactive	50	64.2	794	1,020	1,190	1,160	1,360	1,720	1,770

2.4 Hydraulic Analysis

The 2D rain-on-grid hydraulic models for Mesa County were developed in HEC-RAS Version 5.0.6. The following sections detail the model development and the calibration steps conducted for these models.

2.4.1 Terrain Development

The multiple topographic data sources summarized in Table 1 were first merged into a single 4-foot by 4-foot cell resolution DEM covering the entire analyzed area. To model culvert crossings that are not represented in the raw DEM, automated tools were developed to create a "hydroconnected" DEM. The series of tools connects the low elevations upstream and downstream of a culvert crossing by enforcing the elevation with a linear slope across the road. The resulting voids in the DEM (referred to here as hydroconnectors) result in improved model accuracy by allowing for conveyance through roadways and other embankment structures while also modeling upstream ponding effects. Through sensitivity analyses, 4-foot hydroconnectors were determined to best represent the actual hydraulic conditions for most culvert crossings. The hydroconnector locations and orientations were determined using Wood proprietary tools and through manual edits. Figure 6 shows an example of a hydroconnector enforced in the DEM.

The merged hydroconnector enforced DEM was then clipped to each basin boundary and imported into HEC-RAS to define each model's terrain data.

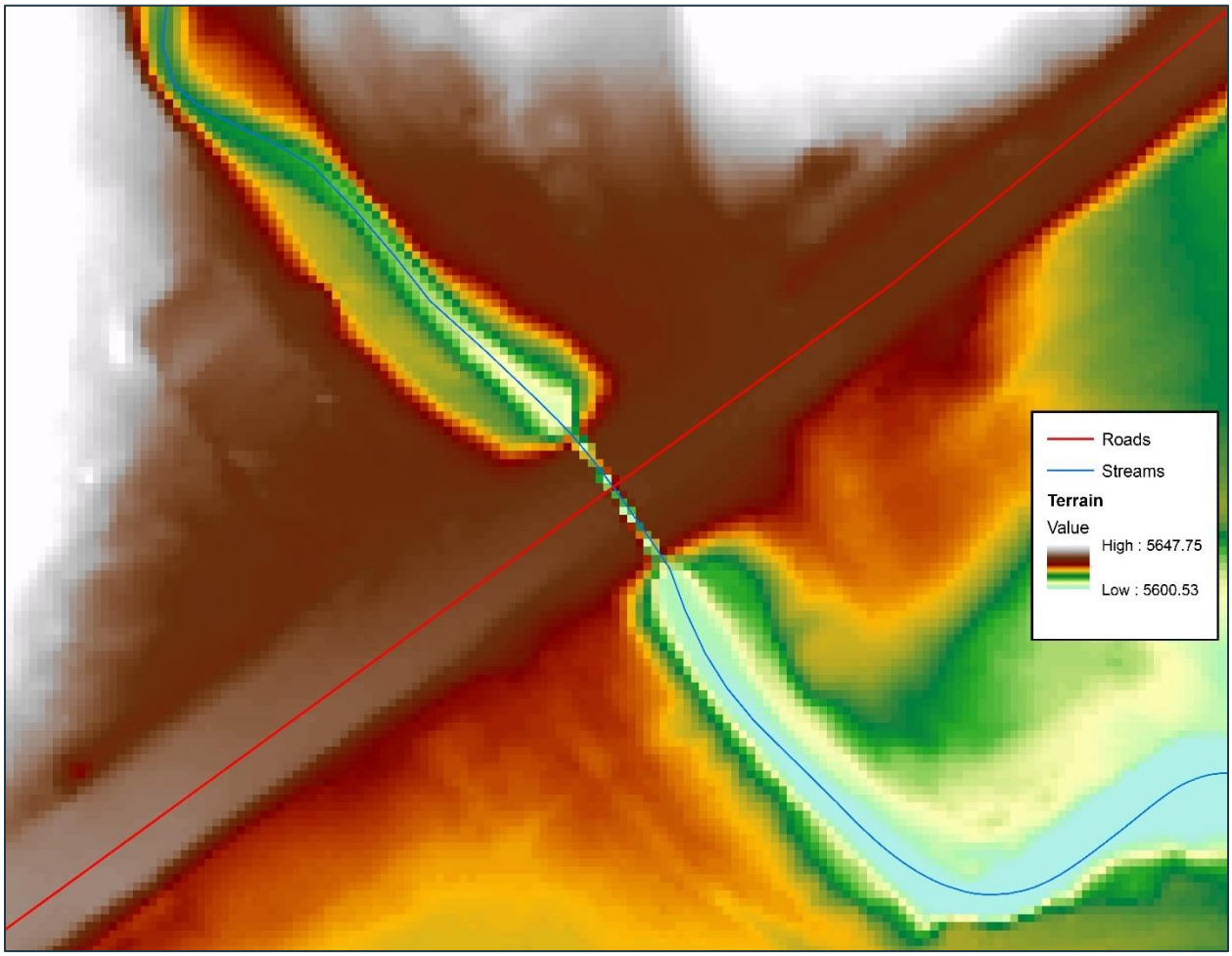

Figure 6: Example Hydroconnector Enforced DEM

2D Flow Area Development

2D flow areas were developed for each of the 20 basins to route the rainfall runoff. The boundaries of the 2D flow areas were determined by buffering the boundaries of the 20 basins by 300 feet to ensure all contributing drainage area is included for each basin, due to small inaccuracies in the basin boundaries, and to provide overlap for floodplain mapping purposes.

The 2D flow area computational mesh was generated within the buffered basin boundaries using an average cell size of 200 feet by 200 feet. Stream centerline breaklines and buffered refinement regions were then enforced in the 2D flow areas to refine the mesh along streams with a drainage area greater than one square mile. Additional breaklines were then added along roadways, railroads, dams, and other embankments or high points in the terrain to add additional refinement and to align the mesh cell faces to these features. Roadway and railroad breaklines were derived from Colorado Department of Transportation (CDOT) data while dam centerline and other embankment breaklines were delineated manually. The average cell spacing for the refinement regions and along the breaklines as well as the starting average cell size for the 2D flow area computational mesh is summarized in Table 5.

2D flow area connections were added to the models to record hydrograph data throughout the model for connecting upstream models to downstream models and for calibration purposes. The average cell size along the 2D flow area connections is also summarized in Table 5. The 2D flow area connections are discussed in more detail in the Boundary Conditions and Calibration sections.

An example of a 2D flow area computational mesh for Mesa County is shown in Figure 7.

Table 5: 2D Flow Area Mesh Cell Sizes and Spacing

2D Flow Area Parameter	Average Cell Size/Spacing (ft)
2D Flow Areas	200
Stream Refinement Regions	50
Grand Junction Refinement Region	100
Breaklines	25-50
2D Flow Area Connections	40-50

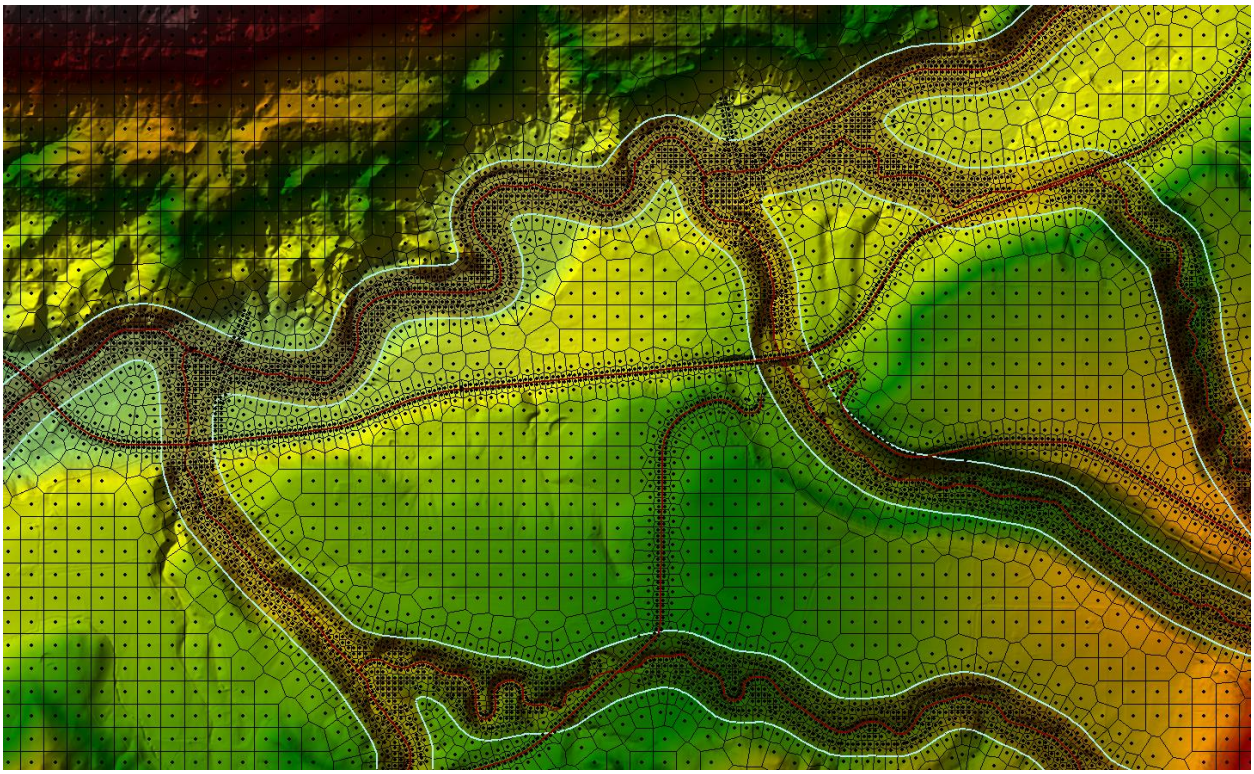

Figure 7: Example 2D Flow Area Mesh

2.4.2 Manning's Roughness

NLCD 2011 data was used to delineate the Manning's n roughness regions for the 2D flow areas. Table 6 summarizes the Manning's n roughness value assigned to each NLCD land cover classification.

Table 6: Land Cover Classification Manning's n Roughness Values

NLCD Value	Land Cover	Manning's n Roughness Value
11	Open Water	0.04
12	Perennial Ice/Snow	N/A
21	Developed, Open Space	0.04
22	Developed, Low Intensity	0.1
23	Developed, Medium Intensity	0.12
24	Developed, High Intensity	0.15
31	Barren Land (Rock/Sand/Clay)	0.03
41	Deciduous Forest	0.12
42	Evergreen Forest	0.12
43	Mixed Forest	0.12
52	Shrub/Scrub	0.07
71	Grassland/Herbaceous	0.04
81	Pasture/Hay	0.03
82	Cultivated Crops	0.035
90	Woody Wetlands	0.07
95	Emergent Herbaceous Wetlands	0.07

2.4.3 Boundary Conditions

Upstream Boundary Conditions

Precipitation hyetographs and inflow hydrographs were defined for the upstream boundary conditions of the 2D flow areas. The basin specific excess precipitation hyetographs determined outside of HEC-RAS were applied evenly across each 2D flow area. All precipitation hyetographs were 24-hour hyetographs starting at the beginning of the simulation and used a 6-minute time step.

There were two types of inflow hydrographs used in this analysis; external computational boundary inflow hydrographs (external) and internal computational boundary inflow hydrographs (internal). The external inflow hydrographs were used to account for unmodeled drainage area upstream of the computational boundary extents. Internal inflow hydrographs were used to link upstream models to downstream models within the analyzed area.

External inflow hydrographs were defined in the models for the three major rivers flowing into Mesa County and for select streams from the leveraged neighboring Delta County and Garfield County BLE studies. Upon review of nearby stream gage data, the shape of the inflow hydrographs for the three major rivers was approximated as a constant value equal to the peak flow rate for the entire duration of the simulation. This assumption was made because the gage data showed that the hydrographs for these rivers typically peaked over the duration of a few weeks, while the simulation run times for this analysis were only over a few days. Table 7 summarizes the streams where an external inflow hydrograph boundary condition was used for this analysis.

Internal inflow hydrographs linked upstream models to downstream models by taking hydrograph data near the outlet of the upstream models and applying it to the downstream models as an inflow hydrograph. The hydrograph data from the upstream models was recorded in HEC-RAS data storage system (DSS) files using 2D flow area connection cross sections. These 2D flow area connections were drawn perpendicular to the floodplains and enforced in the 2D flow area computational mesh, as described in the Hydraulic Analysis

The 2D rain-on-grid hydraulic models for Mesa County were developed in HEC-RAS Version 5.0.6. The following sections detail the model development and the calibration steps conducted for these models.

2.4.4 Terrain Development

The multiple topographic data sources summarized in Table 1 were first merged into a single 4-foot by 4-foot cell resolution DEM covering the entire analyzed area. To model culvert crossings that are not represented in the raw DEM, automated tools were developed to create a "hydroconnected" DEM. The series of tools connects the low elevations upstream and downstream of a culvert crossing by enforcing the elevation with a linear slope across the road. The resulting voids in the DEM (referred to here as hydroconnectors) result in improved model accuracy by allowing for conveyance through roadways and other embankment structures while also modeling upstream ponding effects. Through sensitivity analyses, 4-foot hydroconnectors were determined to best represent the actual hydraulic conditions for most culvert crossings. The hydroconnector locations and orientations were determined using Wood proprietary tools and through manual edits. Figure 6 shows an example of a hydroconnector enforced in the DEM.

The merged hydroconnector enforced DEM was then clipped to each basin boundary and imported into HEC-RAS to define each model's terrain data.

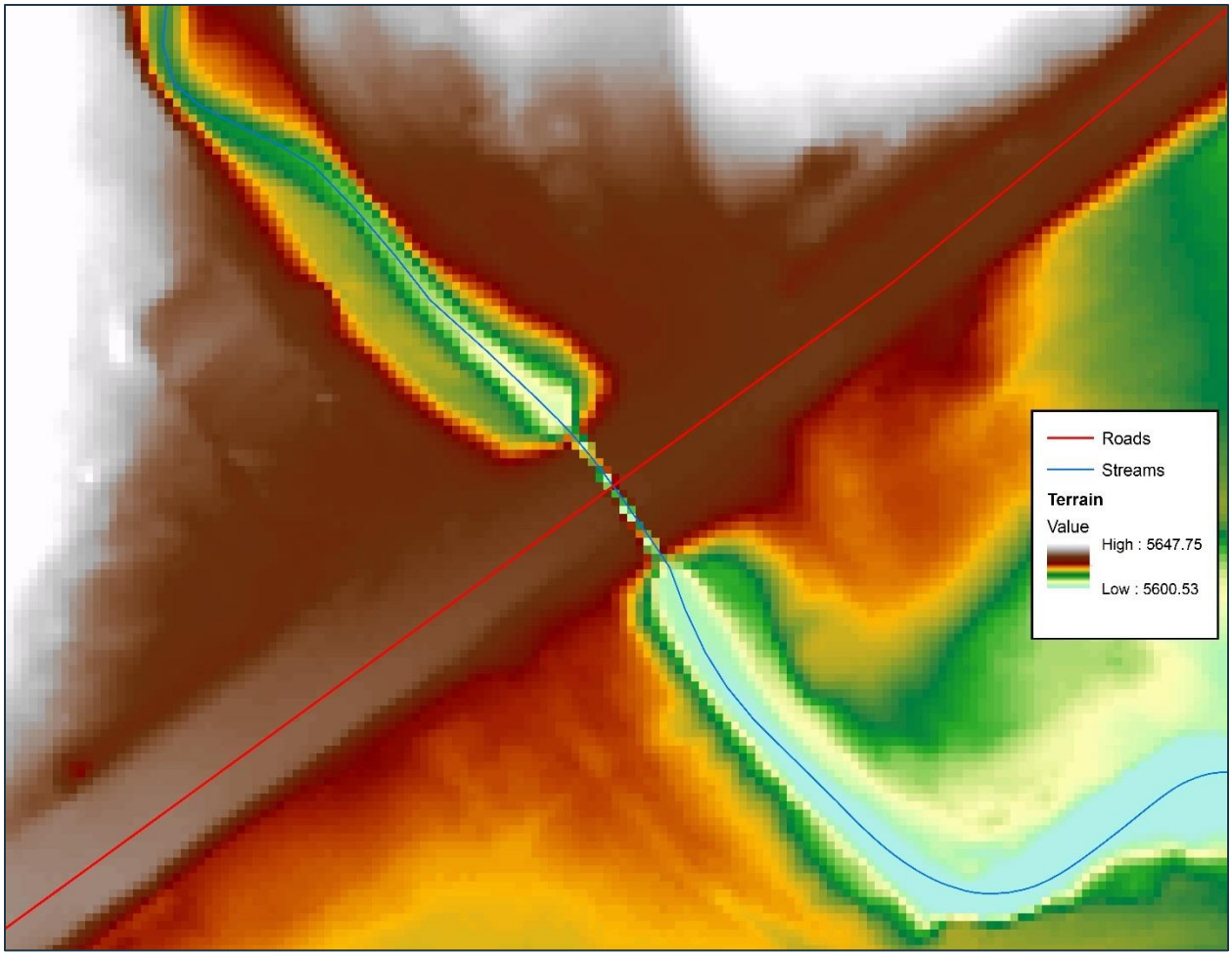

Figure 6: Example Hydroconnector Enforced DEM

2D Flow Area Development section.

A total of four external and internal inflow hydrographs boundary conditions did not follow the standard modeling approach. The modeling approach utilized for these boundary conditions and the reasoning behind why the standard modeling approach was not used is summarized below.

Little Dominguez Creek Tributary 1 – this external inflow hydrograph boundary condition was scoped to utilize leveraged hydrograph data from the neighboring Delta County BLE study. However, that BLE study did not model the 1%- annual chance recurrence interval event, which was modeled in this BLE analysis. To model this event, this hydrograph was approximated by first calculating the peak flow percent difference of the 1%+ annual chance recurrence interval event and the 1% event. This percent difference was then inverted, and the 1% event peak flow was scaled down by this factor to approximate the 1%- event peak flow. The resulting 1%- event peak flow was very close to the 4% event peak flow, so the 4% event hydrograph shape was used to approximate the 1%- event hydrograph shape.

Little Dominguez Creek - this external inflow hydrograph boundary condition was also scoped to utilize leveraged hydrograph data from the neighboring Delta County BLE study. In addition to the 1%- event not being modeled, the Delta County BLE study peak flows for the other recurrence intervals for Little Dominguez Creek were found to be much higher than regression equations peak flows. Additionally, most of the Little Dominguez Creek watershed is within Mesa County, and this external boundary was only necessary because Little Dominguez Creek briefly flows through Delta County before re-entering Mesa

County. Considering all these factors, the hydrograph data was ultimately decided not to be leveraged from the Delta County BLE study and instead sourced from the Mesa County BLE study. The hydrograph results where Little Dominguez Creek exits Mesa County were taken from the first model run and then applied to this external inflow hydrograph boundary condition where Little Dominguez Creek re-enters Mesa County for the second model run. For calibration purposes, this hydrograph was scaled down.

Gunnison River (Sink Creek Basin Model) – this internal inflow hydrograph boundary condition models the Gunnison River inflow into the Colorado River at Grand Junction, CO. As opposed to directly taking the resulting Gunnison River hydrograph from the downstream extents of the upstream basin model (Outlet Gunnison River) to link the models, the Gunnison River inflow hydrographs for each recurrence interval were entered as constant values equal to the difference between the projected stream gage analysis results for the Colorado River just upstream and downstream of the confluence. This ensured the Colorado River peak flows stayed within calibration tolerances downstream of the confluence as opposed to overestimating the Colorado River flows if the Gunnison River was directly linked using the upstream basin model flows. The calibration procedures are discussed in more detail in the Calibration section.

West Creek – this internal inflow hydrograph boundary condition models the West Creek inflow into the Dolores River where they confluence near the intersection of the Beaver Creek, John Brown Creek, and West Creek basin models. This would normally be a standard internal inflow hydrograph boundary condition, however, there is a distinct split flow on West Creek as it flows into the Dolores River. The main stem of West Creek flows into the Dolores River within the borders of the John Brown Creek basin while the split flow flows into the Dolores River within the borders of the Beaver Creek basin. To account for this, the 2D flow area connection that was used to record the hydrograph data for West Creek was split into two 2D flow area connections. The main stream 2D flow area connection was linked to the John Brown Creek basin while the split flow 2D flow area connection was linked to the Beaver Creek basin.

Downstream Boundary Conditions

Normal depth boundary conditions were used for the downstream boundary and overflow boundary conditions for the 2D flow areas. The normal depths, or normal slopes, were determined from taking the average slope from the merged DEM at the respective downstream boundaries. Individual normal depths were determined for defined flow paths exiting the 2D flow areas and general overflow normal depths filled the gaps along the 2D flow area boundary between those normal depth boundary conditions and the upstream inflow hydrograph boundary conditions (if present). This resulted in every computational mesh cell face along the border of the 2D flow area to have a boundary condition so that ponding did not occur along the perimeter.

Table 7: External Inflow Hydrograph Boundary Condition Summary

Stream Name	Source	Notes
Big Salt Wash	Garfield County 2D BLE	
Brush Creek	Garfield County 2D BLE	
Camp Gulch 1	Garfield County 2D BLE	
Camp Gulch 2	Garfield County 2D BLE	
Camp Gulch Trib 1	Garfield County 2D BLE	
Camp Gulch Trib 2	Garfield County 2D BLE	
Camp Gulch Trib 2.5	Garfield County 2D BLE	
Coal Gulch Trib 1	Garfield County 2D BLE	
Coal Gulch Trib 2	Garfield County 2D BLE	
Colorado River	Garfield County 2D BLE	
Colorado River	Stream Gage Analysis	Results taken from the Colorado River Hydrologic Evaluation (Amec Foster Wheeler, 2017). Hydrograph shape approximated as constant peak flow.
Colorado River Trib 1	Garfield County 2D BLE	
Colorado River Trib 2	Garfield County 2D BLE	
Colorado River Trib 3	Garfield County 2D BLE	
Demaree Canyon	Garfield County 2D BLE	
Demaree Canyon Trib 1	Garfield County 2D BLE	
Dolores River	Stream Gage Analysis	Hydrograph shape approximated as constant peak flow.
Dry Canyon Wash	Garfield County 2D BLE	
Dry Canyon Wash Trib 1	Garfield County 2D BLE	
East Salt Creek	Garfield County 2D BLE	
East Salt Creek Trib 1	Garfield County 2D BLE	
East Salt Creek Trib 2	Garfield County 2D BLE	
East Salt Creek Trib 3	Garfield County 2D BLE	
East Salt Creek Trib 4	Garfield County 2D BLE	
East Salt Creek Trib 5	Garfield County 2D BLE	
Gunnison River	Stream Gage Analysis	Hydrograph shape approximated as constant peak flow.
Little Dominguez Creek	Mesa County 2D BLE	Hydrograph determined from this 2D BLE analysis. See detailed description.
Little Dominguez Creek Trib 1	Delta County 2D BLE	There was no modeled 1%- annual chance recurrence interval event. Had to approximate. See detailed description.
Mack Wash	Garfield County 2D BLE	
Prairie Canyon	Garfield County 2D BLE	
Roan Creek	Garfield County 2D BLE	
Roan Creek Trib 1	Garfield County 2D BLE	
Roan Creek Trib 2	Garfield County 2D BLE	
Ruby Lee Trib	Garfield County 2D BLE	
West Salt Creek	Garfield County 2D BLE	
West Salt Creek Trib 1	Garfield County 2D BLE	
West Salt Creek Trib 2	Garfield County 2D BLE	
West Salt Creek Trib 3	Garfield County 2D BLE	
West Salt Creek Trib 4	Garfield County 2D BLE	

2.4.5 Computational Parameters

Each recurrence interval model simulation was run for 4 days to allow the peak of the hydrograph resulting from the 24-hour storm to pass through the entire county. The computational timestep varied from 3 seconds to 5 seconds depending on model size and stability. This range of computation timestep provided stable model results with minimal numerical inaccuracies while maintaining reasonable run times. This range in the computation timestep was determined to be appropriate for the level of detail of this study. The average volume accounting error for all models was less than 0.2 percent, indicating the models were satisfactorily achieving a conservation of mass. For models with large stream inflow hydrographs, an initial condition ramp-up time was used to gradually increase the inflow hydrograph before the simulation started so that the stream would not go from dry to flood stage conditions rapidly. This also improved model stability during the earlier stages of the simulations.

2.4.6 Calibration

The 2D rain-on-grid models were calibrated against stream gage analysis peaks flows and regional regression equations peak flows. The calibration peak flows where compared against hydrographs recorded throughout the models in HEC-RAS DSS files using 2D flow area connection cross sections. The placement of the 2D flow area connection calibration cross sections were guided by HUC-12 watershed boundaries and basin boundaries.

Stream gage analysis peak flow data was the primary calibration source and was projected along the gaged streams using the methodology outlined in the Water Resources Investigations Report (WRIR) 99-4190 (USGS, 2002). For ungagged streams or reaches of stream where stream gage results could not be projected due to the limits established in the WRIR 99-4190 report, regional regression equation peak flow data was used for calibration. Figure 8 shows the calibrations points used in this analysis and classifies the type of calibration point.

The 1% annual chance recurrence interval event was the primary focus of the calibration process since only the floodplains associated with this recurrence interval were developed. The results of the first several iterations of the 1% annual chance recurrence interval were used to make CN adjustments across the county within the limits of the NRCS TR-55 guidance. The goal of the CN adjustment was to get the majority of the modeled 1% annual chance recurrence interval peak flows within 25% of the stream gage analysis calibration peak flows and within 1 standard error of prediction (SEP) for the regression equation peak flow calibration points. The secondary goal was to minimize the absolute percent difference between the modeled and calibration peak flows. This calibration was specifically geared toward tributaries with smaller drainage areas to ensure that the peak flows on these streams were close to the calibration flows. This resulted in the peak flow on streams with larger drainage areas to initially overestimate when compared to calibration flows. These streams were calibrated using the methods described below.

Typically, the precipitation depths for large watershed models like the ones developed for this BLE analysis are reduced using areal reduction factors. Areal reduction factors are used to convert point rainfall estimates to area-averaged rainfall estimates. They are "reduction" factors because an area-averaged precipitation depth is lower than a small localized precipitation depth. Areal reduction factors can significantly reduce the precipitation depths, especially for large watersheds. Using areal reduction factors helps reduce peak flows so that the peak flow on larger streams is not overestimated, however, if they are applied across an entire watershed, it often results in the smaller tributaries higher in the basin having their peak flows underestimated. This results in floodplains that are too small and do not accurately show the true risk.

Instead of using precipitation areal reduction factors, this analysis utilized negative internal boundary condition hydrographs to reduce peak flows only on large streams within Mesa County. This methodology

reduces the peak flows on the larger tributaries in the basin by applying a scaled down inverted hydrograph while leaving the rest of the model unaffected.

Negative internal boundary condition hydrographs were used on five major streams within Mesa County, including Buzzard Creek, the Dolores River, the Gunnison River, Kannah Creek, and Plateau Creek. The Colorado River did not require any negative internal boundary condition hydrographs because the smaller tributaries flowing into the Colorado did not cause a significant increase in peak flow due to the large differences in magnitude and because the Gunnison River inflow hydrograph was reduced to ensure the peak flow on the Colorado River stayed within calibration tolerances, as discussed in the Boundary Conditions section.

It was found that negative internal boundary condition hydrographs were needed when the modeled drainage area of a tributary started to increase above 100 square miles. This is illustrated for the Plateau Creek watershed in Figure 9, which is 100% within the computational boundaries of this analysis. Through testing, the maximum percentage reduction without causing significant numerical instabilities was found to be 15%. For streams where the initial modeled peak flow was greater than 15% different from the calibration targets, multiple negative internal boundary condition hydrographs were utilized.

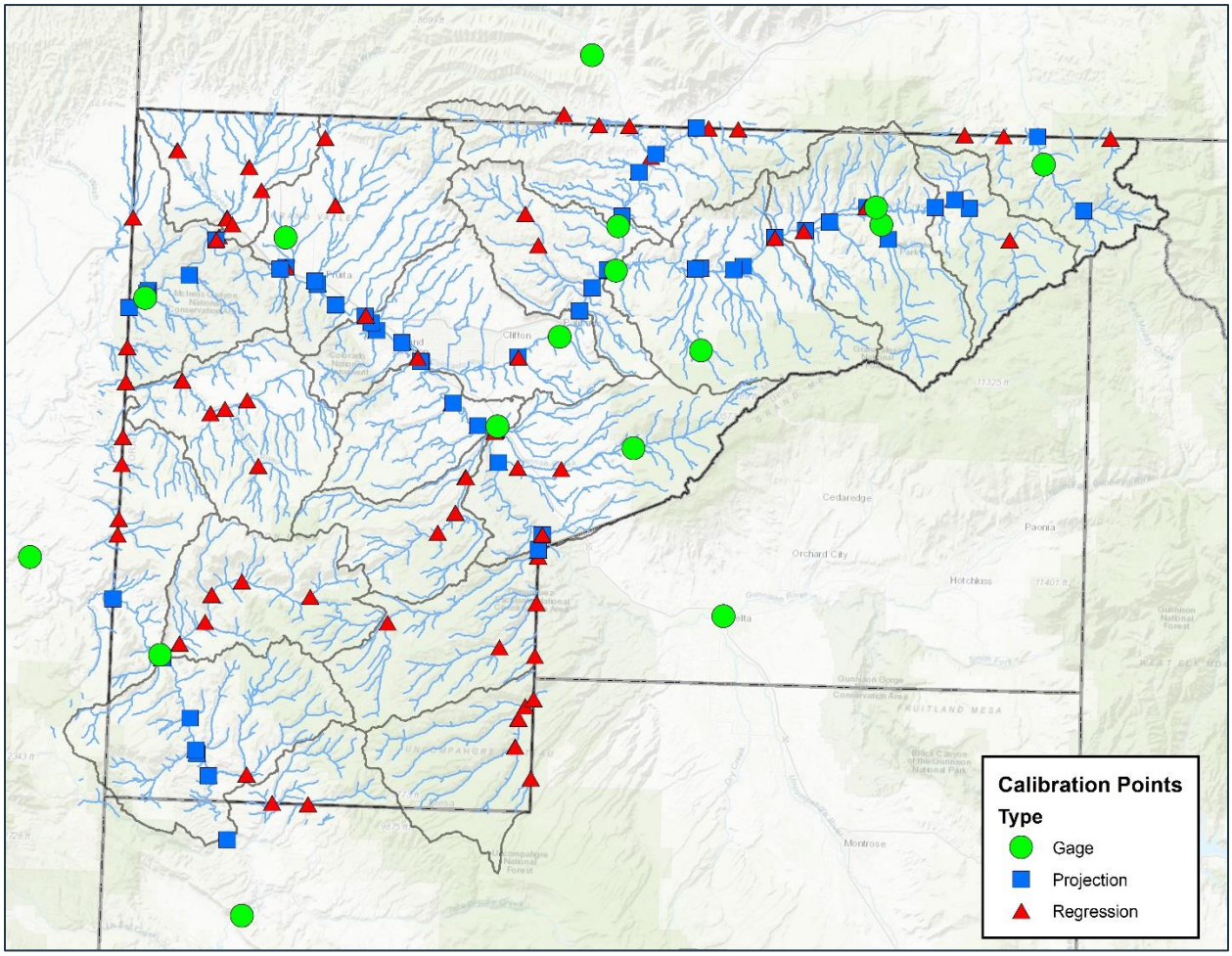

Figure 8: Calibration Point Summary

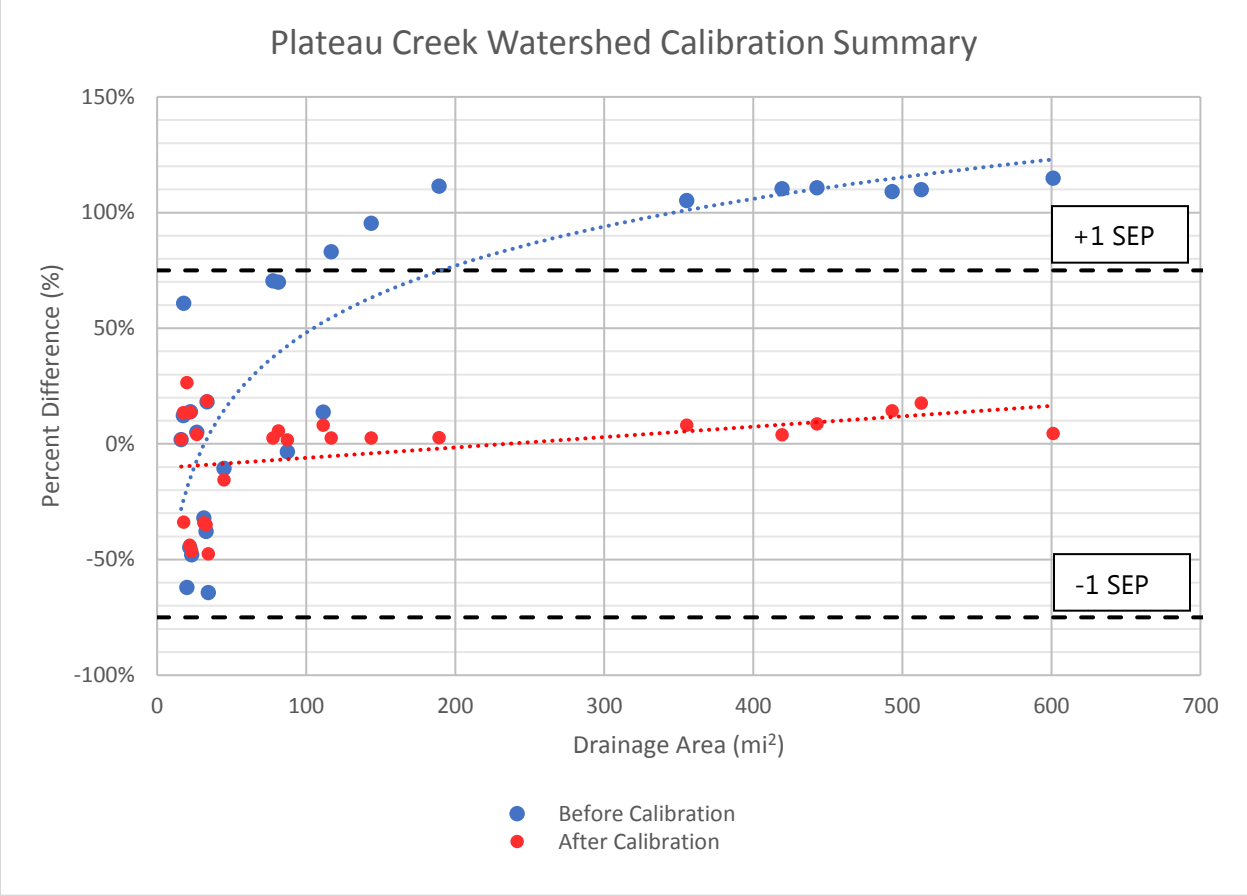

Figure 9: Plateau Creek Calibration Summary

Table 8 summarizes the final calibration results for all 20 basins. 95% of the calibration points were within 1 SEP of the regression equation calibration flows or 25% of the stream gage analysis calibration flows. 100% of the calibration points were within 2 SEP of the regression equation calibration flows or 50% of the stream gage analysis calibration flows.

Table 8: Final Model Calibration Results

Model	Average Percent Difference (%)	Number of Calibration Points	Calibration Points Outside 1 SEP[1]	Percentage of Points Outside 1 SEP[1]	Calibration Points Outside 2 SEP[2]	Percentage of Points Outside 2 SEP[2]
Beaver Creek	-30%	4	0	0%	0	0%
Big Creek	-13%	11	0	0%	0	0%
Big Salt Wash	-1%	8	0	0%	0	0%
Buzzard Creek	7%	6	0	0%	0	0%
Divide Creek	22%	7	4	57%	0	0%
Dominguez Creek	17%	6	0	0%	0	0%
East Creek	-30%	6	1	17%	0	0%
Salt Creek	-12%	6	0	0%	0	0%
Escalante Creek	-21%	8	1	13%	0	0%
Jerry Creek	7%	6	0	0%	0	0%
John Brown Creek	-1%	9	0	0%	0	0%
Kannah Creek	-3%	12	0	0%	0	0%
Little Dolores River	-2%	7	0	0%	0	0%
McDonald Creek	15%	6	0	0%	0	0%
Mesa Creek	-33%	1	0	0%	0	0%
Outlet Gunnison River	1%	6	0	0%	0	0%
Roan Creek	6%	8	0	0%	0	0%
Sink Creek	-1%	8	0	0%	0	0%
Vega Reservoir	0%	12	1	8%	0	0%
West Creek	-23%	7	0	0%	0	0%
Mesa County	**-5%**	**144**	**7**	**5%**	**0**	**0%**

Notes

1. Or 25% for stream gage analysis calibration flows.
2. Or 50% for stream gage analysis calibration flows.

2.5 Floodplain Mapping

1% annual chance recurrence interval floodplains were developed for all streams within Mesa County with drainage areas greater than one square mile. This follows FEMA guidance for setting the extents of flood studies since drainage areas less than one square mile are considered local drainage problems (FEMA, 2003). The floodplains were developed using Wood proprietary tools that take raw HEC-RAS outputs and produce smoothed and corrected floodplains for the select streams.

The 1% annual chance recurrence interval floodplains were added to the Discovery Maps presented to the communities and other stakeholders within Mesa County during the Discovery Meeting. The Discovery Meeting is discussed in more detail in the following section. The 1% annual chance recurrence interval floodplains are also provided as supplemental data to this report to be used as best available information.

3.0 References

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APPENDIX C

OPERATION AND MAINTENANCE MANUAL
FOR
COLORADO RIVER AT GRAND JUNCTION
COLORADO

SACRAMENTO DISTRICT
U.S. ARMY CORPS OF ENGINEERS

OPERATION AND MAINTENANCE MANUAL

COLORADO RIVER, GRAND JUNCTION
COLORADO

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EXHIBIT G - SUGGESTED FLOOD FIGHTING METHODS

SECTION I - INTRODUCTION

1-01. Project Authorization. The construction of local flood control protection measures along the Colorado River, in the vicinity of Grand Junction, Colorado, was authorized under Section 205 of the 1948 Flood Control Act as amended (33USC7015).

1-02. Purpose of the Manual. The purpose of this manual is to provide local interests with pertinent information as to the details of operation and maintenance for the levee and appurtenances. The general intent of the procedures contained herein is to ensure that the structures and facilities, provided by the United States for flood protection and recreation, are continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain maximum benefits and insure a safe project. This manual was prepared by the Sacramento District, U.S. Army Corps of Engineers, which is responsible for the project engineering, design, and construction. The Sacramento District is also responsible for monitoring project operations and maintenance after the completion of the project.

1-03. Project Location. The study area is located along the Colorado River in Grand Junction, Mesa County, Colorado. This area is in west-central Colorado approximately 30 miles east of the Utah State border (See EXHIBIT A, Plates 1 & 2). The specific project reach extends approximately 3,100 feet upstream on the Colorado River, beginning immediately upstream of the confluence of the Colorado and Gunnison Rivers (See EXHIBIT A, Plate 3). The flood-prone project area along the Colorado River in Grand Junction extends from the Denver-Rio Grande Western Railroad (DRGWRR) bridge, which crosses the Colorado River just upstream of its confluence with the Gunnison River, to the uranium tailings pile near 9th Street.

1-04. Description of Project Works. The Grand Junction, Colorado River Flood Control Project consists of a setback levee, approximately 3,100 feet in length, varying in height from approximately 4 feet to 10 feet, including freeboard. A standard section will consist of a 12-foot crown width, with a 1V on 3H sideslope waterside and a 1V on 2H sideslope landside (See Exhibit A, Plate 4). The project also includes three small detention basins to control interior flooding, mitigation plantings of 24 cottonwood trees, a patrol road and turnouts along the levee crown, an access road to Watson Island, and an impermeable clay berm at the downstream limit of the project. Refer to the □As Constructed□ drawings for details relating to the specific features of the project works. The project was initially evaluated by the Corps in □Colorado River, Grand Junction, Colorado Section 205 Detailed Project Report for Flood Control and Environmental Assessment□ (July 1992). As determined by the Section 205 Report, a setback levee designed for the 500-year level of protection provides the maximum net benefits.

1-05. Protection Provided. The area subject to flooding along the study reach is a mixed use area of industrial, commercial, and low income residential structures, consisting of approximately 100 acres (See EXHIBIT A, Plate 5). Commercial and industrial businesses include warehousing, auto body shops, manufacturing, construction yards, and salvage yards.

The flooding problems along the Colorado River in the project reach are the result of snowmelt flooding. The worst flooding occurs when the melting snowpack is augmented by rain. Snowmelt floods are characterized by sustained periods of high flow and marked daily fluctuations, with peak flows occurring sometime during the months of April, May, or June. When completed, the Grand Junction, Colorado Flood Control Project will provide adequate protection, up to the 500-year event, to this flood-prone area. The south bank of the river rises approximately 70 feet above the river through the project reach, and no flood-prone developments exist there.

1-06. Definitions. Some pertinent definitions applicable to this manual are:

District Engineer: The chief executive of the Sacramento District, U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922. In certain contexts, the term may be construed to include representatives of the District Engineer.

Superintendent: The local official(s) with responsibility (pursuant to Regulations) for developing and maintaining, and directly in charge of an organization charged with the efficient operation and maintenance of flood control facilities and/or recreation features provided by the United States.

Regulations: Part 208--Flood Control Regulations, Chapter II--Corps of Engineers, Department of the Army, Title 33--Navigation and Navigable Waters, Code of Federal Regulations. These are the rules that govern local interests in operating and maintaining flood control projects. (See EXHIBIT B).

Right (or Left) Bank: The right (or left) side of a stream or waterway as the viewer faces downstream.

1-07. Construction Data and Contractors. Construction contracts required by the U.S. Army Corps of Engineers to complete the project works were as follows:

Contract No. DACW94-C-0153; Specification No. 9349; M.A. Concrete Construction, Inc., Grand Junction, CO; 30 September 1994 to 31 July 1996.

SECTION II - LOCAL COOPERATION

2-01. Limits of Responsibility.

Prior to the start of construction, the City of Grand Junction was designated as the agency to fulfill the local interests responsibilities. The City has entered into agreements with the Department of the Army. The Local Cooperation Agreement (LCA) was executed on 8 April, 1994. (See Exhibit C)

2-02. Assurances of Local Cooperation.

After the Government has turned the completed project, or functional portion thereof, over to the City of Grand Junction, it shall be the responsibility of the District Engineer to supply the local interests with a copy of the Project Operations and Maintenance Manual. In accordance with the required assurances of local cooperation, it shall be the responsibility of the City of Grand Junction to operate, maintain, repair, and rehabilitate the completed project in accordance with Federal Regulations. The local interests will also be responsible for preventing impairment of the design capacity of the project.

2-03. Responsibility for Flood Control Facilities

A. The City of Grand Junction shall be responsible for all operation, maintenance, replacement, and rehabilitation, without cost to the Government, of all completed facilities constructed to aid in Flood Control in accordance with regulations or directions as prescribed by the Government. (See EXHIBIT C - Local Cooperation Agreement for Flood Control).

B. The City of Grand Junction hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon land which it owns or controls for access to the Project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project. If an inspection shows that the City of Grand Junction for any reason is failing to fulfill its obligations under this Agreement without receiving prior written approval from the Government, the Government will send a written notice to the City of Grand Junction. If the City of Grand Junction persists in such failure for 30 calendar days after receipt of the notice, then the Government shall have a right to enter, at reasonable times and in a reasonable manner, upon lands the City of Grand Junction owns or controls for access to the Project for the purpose of competing, operating, maintaining, repairing, replacing, or rehabilitating the Project. No completion, operation, maintenance, repair, replacement, or rehabilitation by the Government shall operate to relieve the City of Grand Junction of responsibility to meet its obligations as set forth in the Agreement, or to preclude the Government from pursuing any other remedy at law or equity to assure faithful performance pursuant to the Agreement.

2-04. Transfer of Responsibility.

Responsibility for operating and maintaining the completed project works, or functional portion thereof, is formally conveyed to the local sponsors upon completion of each construction contract. EXHIBIT B, Paragraph 208.10 (a) (10) of Regulations (Part 208 - Flood Control Regulations, Chapter II - Corps of Engineers, Department of the Army, Title 33 - Navigation and Navigable Waters, Code of Federal Regulations) provides that:

This Operation and Maintenance Manual for the completed project, is furnished to assist local interests in carrying out their obligations.

Letters of acceptance from the local sponsors are attached as EXHIBIT C.

SECTION III - MANAGEMENT & INSPECTION

3-01. Responsibilities of the District Engineer. The District Engineer is the authorized engineer, or authorized representative, of the U.S. Army Corps of Engineers, Sacramento District. A general outline of the responsibilities of the Superintendent is contained in Section 208.10, Subsection (a) of the Regulations. Subparagraph (2) is an overview of these responsibilities. It reads:

> The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of the Army, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the □Superintendent□, who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

A. Furnish □As Constructed□ drawings of the project works upon issuance of this manual to the local interests.

B. Make periodic inspections of the project works and notify the local interests of any repairs or maintenance measures which the District Engineer deems necessary in addition to measures taken by the Superintendent.

C. Submit to the Office, Chief of Engineers, all cases of noncompliance with full details thereof for determination of corrective measures to be taken.

D. Make prior determination that any proposed encroachment, improvement, excavation, construction within the rights-of-way, or alteration of the project works, will not adversely affect the functioning of the protective facilities.

E. Assist local interests, as may be practicable, in their duties of ascertaining storms developments having flood-producing potential and assembling flood-fighting operations to the extent permitted by existing laws and regulations.

F. Assist, advise, or otherwise suggest the course of action to be taken if the project works have sustained serious damage which is beyond the capability of the local interests to repair.

3-02. Responsibilities of the Superintendent. The Superintendent is the person appointed by the local interests to be directly in charge of an organization which will be fully responsible for the continuous operation and inspection of the project works. A general outline of the responsibilities of the Superintendent is contained in Section 208.10 (a) of the Code of Federal Regulations (See EXHIBIT B). Major specific duties of the Superintendent include the following:

A. Training Key Personnel. Key personnel shall be trained in order that regular maintenance work may be performed efficiently and to ensure that unexpected problems related to flood control may be handled in an expeditious and orderly manner. The Superintendent should have available, the names, addresses, and telephone numbers of all his key personnel and a reasonable number of substitutes. These key persons should, in turn, have similar data on all of those who will assist them in the discharge of their duties. The organization of key personnel should include the following:

(1) An Assistant to act in the place of the Superintendent in case of his absence or indisposition.

(2) Sector foremen in sufficient numbers to lead maintenance patrol work of the levee, inspect the channel, and operate the structures properly during flood periods. High qualities of leadership and responsibility are necessary for these positions.

B. Files and Maintenance Records. The Superintendent shall maintain a file of reports, records, and drawings concerning the project works readily available at all times to the District Engineer.

C. Preventing Encroachment or Trespass on Rights-of-Way. In accordance with the provisions of Regulations 208.10 (a) (4), no encroachment or trespass, which will adversely affect the efficiency of the operation and maintenance of the project works, shall be permitted on the rights-of-way for the protective facilities. The Superintendent will, therefore, cause notices to be posted at conspicuous places along the project rights-of-way directing public attention to this regulation. The Superintendent shall take whatever action is necessary, under local ordinances and authorities, to remove any unauthorized encroachment or to prosecute the trespassers.

D. Coordination of Local Activities. In accordance with the provisions of Regulations 208.10 (a) (9), the Superintendent will, during periods of flood flow, coordinate the functions of

all agencies, both public and private, that are connected with the protective works. Arrangements shall be made with the local law enforcement agencies, street departments, railroad, utilities and any other concerned local interests for developing a coordinated flood-fighting program. An outline of this program shall be filed with the District Engineer;

E. Responsibilities for Repair and Maintenance of Project Works. In accordance with the provisions of Regulations 208.10 (b) (1), the Superintendent will be fully responsible for maintenance, repairs, and the methods used to accomplish them. All repairs shall be made in accordance with standard engineering practice; to line, grade and in accordance with details shown on the □As Constructed□ drawings for the project works. No change or alteration shall be made in any feature of the project works without prior determination by the District Engineer that such alteration will not adversely affect the stability and functioning of the protective facilities. Plans and specifications of all changes or alterations that may be proposed by the Superintendent shall be submitted for forwarding to the District Engineer for investigation and approval before commencement of the work.

3-03. Field Inspections.

A. The Superintendent must make periodic inspections to ensure that effective maintenance is continuing. These inspections shall determine the condition of the various components of the project and disclose any areas that require repair or replacement. Inspections shall be made as stated in Regulations:

1. Prior to the beginning of each flood season to ensure the structural integrity of the project works, allowing sufficient time to complete any repairs determined necessary by inspection.

2. After each period of high water to ensure the structural integrity of project works following the flood period.

3. At intervals not exceeding 90 days.

4. And at any intermediate times as may be required to maintain a safe and efficient project.

B. In addition, inspections shall be made after earthquakes based upon the following criteria:

(1) For earthquakes measuring less than 5.0 on the Richter Scale, inspections shall be performed when the epicenter is within 3 miles of the project.

(2) For earthquakes measuring 5.0 to 6.0 on the Richter Scale, inspections shall be performed when the epicenter is less than 30 miles from the project.

(3) For earthquakes measuring 6.0 or higher on the Richter Scale, inspections shall be performed when the epicenter is less than 50 miles from the project.

(4) Inspections shall also be performed after any earthquake in which specific reports of damage are received.

C. The suggested checklists and instructions, shown as EXHIBIT D, should be followed to ensure that features of the project works are not overlooked during inspections. These checklists are to be used to implement required repairs and to prepare the semiannual reports.

D. During inspections, particular attention is to be paid to the following:

1) Condition of the main floodway noting obstacles and debris which could pose a threat to the levee or bridge piers during periods of high flow.

2) Condition of levee, riprap and any recent repairs.

3) Condition of structures, culverts, flap gates, and slide gates.

4) Condition of access and service roads, especially to areas where problems are likely to develop.

5) Availability of emergency supplies (quantity, location, condition).

6) Communications with operating personnel (telephone, radio).

7) Availability of personnel on short notice (operators, labor, etc.).

3-04. Semiannual Reports. In accordance with the provisions of the Flood Control Regulations, paragraph 208.10 (a) (6), the Superintendent shall submit a semiannual report to the District Engineer within a 10-day period following 1 October and 15 April. The report will comprise statements of the following:

A. The physical condition of the protective works as summarized from logs of inspections.

B. Flood-fighting activities during the report period and the behavior of the protective works during floods.

C. Prosecutions for encroachment or trespass of any individuals that have affected the efficient operation or maintenance of the project.

D. Permits issued for rights-of-way or use of rights-of-way.

E. Permits issued for improvement of construction within the project rights-of-way.

F. Maintenance measures taken; nature, date of construction, and date of removal of temporary repairs; date of permanent repairs.

G. Fiscal statement of the cost for maintenance and operation for the report period.

H. Any unusual, abnormal, or unexpected conditions or occurrences bearing on the stability or effectiveness of the protective works.

I. It is suggested that photographs showing any areas of concern be included.

A suggested form for submission of the semiannual report is included as EXHIBIT E. A copy of the inspectors' field notes as recorded on a check list (EXHIBIT D) will be made an enclosure to the semiannual report. Photographs may be used to supplement the narrative portion. The report is to be submitted to the District Engineer, Sacramento District, U.S. Army Corps of Engineers, 1325 J Street, Sacramento, California 95814-2922.

3-05. Encroachment Permits.

A. Improvements for local flood protection and the associated rights-of-way are owned, operated, and maintained by the City of Grand Junction in accordance with the Regulations. Paragraph 208.10 (a) (5) of Regulations provides that permits for use of the rights-of-way and construction of any improvements of flood control projects so owned, operated, and maintained are subject to the approval of the District Engineer.

B. Applications for use of flood control project rights-of-way should be addressed to the City of Grand Junction. The City of Grand Junction will forward the application to the District Engineer together with recommendations and the reasons for encroachment. It is suggested that a draft copy of the permit be included with the application and recommendations so any objectionable features of the permit can be eliminated prior to its approval. The proposed permit should state the exact use of rights-of-way for which permission is being required and any conditions or restrictions that apply. It should be signed by the applicant and a representative of the City of Grand Junction. A drawing, sketch, or detailed plan is required to show the exact location and nature of the work to be permitted, and the proposed method of its execution should be attached to the copy of the proposed permit.

D. If the use proposed by an applicant could result in damage to the rights-of-way or associated flood control structures, it is suggested that the applicant be required to post a bond to protect the local interests from any costs for removal, repair, or restoration. This bond will guarantee that the permittee faithfully meets conditions imposed by the approved permit. In such

cases, the permit would state the amount and conditions of the bond.

E. In cases involving construction, approval must be given by the District Engineer that such improvements will not affect the efficient operation and maintenance of the project works. All construction shall be performed under standard engineering practice. Upon completion of the improvement, □As Constructed□ drawings or prints showing such improvements as finally constructed shall be furnished to the District Engineer.

F. The City of Grand Junction may be responsible for obtaining permits needed for major repairs. The City of Grand Junction should coordinate all major repair efforts with the U.S. Army Corps of Engineers, Sacramento District, the Colorado Resources Agency, and the U.S. Fish and Wildlife Service to avoid environmental problems which may arise with the permit Public Notice.

G. A permit format that has been utilized by a number of cities and flood control districts and agencies is attached as EXHIBIT F.

SECTION IV - OPERATION & MAINTENANCE

4-01. Reference to Approved Regulations. This manual is submitted in accordance with provisions of Title 33 - Navigation and Navigable Waters, Chapter II, Corps of Engineers, Department of the Army, Part 208 - Flood Control Regulations. (A copy is included as EXHIBIT B)

4-02 General Provisions. The general provisions of the Flood Control Regulations contained in paragraphs 208.10 (a) (1) through 208.10 (a) (10) are quoted as follows:

(1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of the Army, as required by law, shall appoint a permanent committee consisting of, or headed by an official hereinafter called the □Superintendent,□ who shall be responsible for the development and maintenance of, and directly in charge of an organization responsible for the efficient operation and maintenance of all structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way of the protective facilities.

(5) No improvement shall be passed over, under or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project rights-of-way, nor shall any change be made in any features of the work without prior determination by the District Engineer of the Department of the Army or his authorized representative that such improvement, excavation,

construction or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations found to be desirable shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the function of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer, or if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished to the District Engineer after completion of the works.

(6) It shall be the duty of the Superintendent to submit a semiannual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

(7) The District Engineer or his authorized representative shall have access at all times to all portions of the protective works;

(8) Maintenance measures or repairs, which the District Engineer deems necessary, shall be promptly taken or made.

(9) Appropriate measures shall be taken by local authorities to ensure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods.

(10) The Department of the Army will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under this part.

4-03. Levee Maintenance. Inspections shall be made to determine maintenance measures necessary to ensure serviceability of the levee to withstand flows up to the design flood event. These inspections shall be made by the Superintendent as previously stated in Section 3-03 - Field Inspections. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. These inspections shall be made to ensure that the following maintenance measures are being effectively carried out:

A. No unusual settlement, sloughing, or material loss of grade has taken place. In all cases where the levee crown grade settles below the design elevations, the crown grade must be raised to the original design elevation. The levee cross section shall be maintained to its original condition as much as practicable. Generally, all material in any failed zone should be removed. Fill placement preparation shall consist of removing all vegetation, trash, debris or rock greater than six inches in size. The surface to receive fill shall be scarified to a depth of approximately six inches. New fill material similar to that

used in the original construction is to be placed and compacted in layers to obtain design grades.

B. Service/patrol roads along or on the levee shall be maintained in a usable condition during all-weather conditions, especially during periods of precipitation to allow vehicular patrols and monitoring of levee performance. All holes, soft areas, cracks, or damaged road surfaces are to be repaired annually. Where service roads have settled and are to be repaired, gravel that is salvageable may be removed, stored, and reused.

C. The landside slope and toe shall be maintained to control seepage and prevent sand boils or saturated areas from developing. Any signs of seepage, sand boils, or wet areas should be immediately reported to the City Engineer (See EXHIBIT G, Page 1).

D. Drains through the levee and drainage gates shall be maintained in good working condition and unobstructed by debris or material to prevent the build-up of high pressure heads behind the gates.

E. In locations where riprap exists, the designed thickness shall be maintained and any locations of displaced, eroded, or removed stone shall be replaced to at least the original thickness.

F. No action shall be taken which will compromise erosion protection of the earth structure. An example of an inappropriate action would include burning grass or weeds along the embankment or toe areas just prior to the rainy season.

G. Unauthorized motorized vehicular traffic on the levee shall not be tolerated.

H. No encroachments shall be made on the levee rights-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

I. Burrowing animals found in the embankments shall be controlled and removed. The dens and runways shall be opened, then thoroughly compacted as they are backfilled. Dens and runways formed within the levee by burrowing animals are frequently the cause of levee failure during flood stages.

J. Growth of vegetation shall not be allowed on the levee and shall be removed. Any holes created by removal of vegetation shall be backfilled and compacted to bring the levee back to design.

4-04. <u>Levee Operation</u>. Operational requirements consist of monitoring for conditions which can adversely affect the safe performance of the levee. Areas of concern that can affect the safe operation of the earth structure are described below.

A. Look for signs of seepage along the landside slopes or toes. Where levee or foundation material is being transported with the seepage, this condition evidences uncontrolled seepage which requires immediate remedial action because levee failure can result.

B. Inspect for signs of scour or erosion activity along the levee. These conditions, if uncorrected, can often result in progressive levee distress and ultimate failure.

C. Inspect for settlement or depressions resulting in low areas along the levee which can lead to possible overtopping.

D. Look for signs of distress such as cracks both longitudinal or transverse, loss of grade, sloughs, or slides which can indicate structural distress of the levee.

Appropriate advance measures will be taken to ensure the availability of adequate labor and materials to meet all contingencies. Sources for equipment suited for earthwork and riprap replacement shall be located. Sources for levee fill and stone for riprap which can be made readily available shall be nearby. Immediate steps shall be taken to control any condition which endangers the levee and to repair distress or damaged areas.

4-05 Riprap Maintenance. Portions of the levee protected by riprap shall be inspected as prescribed in Section 3-03 - Field Inspections. Displaced riprap shall be replaced in order to maintain design grade. The slope protection shall be replaced as soon as practical after the recession of flood water and before the next flood run-off. Furthermore, particularly close attention shall be given to the following:

A. Trees and brush should not be allowed to grow through the riprap to the extent that it displaces the stone protection from the levee.

B. In the event an inspection reveals that due to scour, settlements or other causes, slope protection on the levee is required beyond the limits of the original construction, local interests shall provide additional stone protection as needed to protect the completed work. The work shall be done in a manner acceptable under standard engineering practice.

4-06. Channel Maintenance. Inspections shall be made semiannually, before and after the flood season, to ensure that the following maintenance measures are being effectively carried out:

A. The channel or floodway is clear of large debris (downed trees, etc.) which could become lodged against the banks or bridge piers during periods of high water flow. Such obstructions shall be removed and disposed of properly.

B. The channel or floodway is not being restricted by the building of unauthorized structures or other encroachments.

C. Approach and egress channels, adjacent to the improved channel or floodway, are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

D. Shoaling or aggradation at the inlets or outlets of side drainage structures does not occur. All drains shall be kept open and unobstructed at all times. Particular attention should be given to the banks to ensure that they are not being damaged by rain or wave wash, and that no sloughing of banks has occurred.

If any adverse conditions are disclosed, immediate steps will be taken to remedy them.

4-07. Flap Gate Maintenance. Flap gates shall be examined, lubricated, and trial operated at least twice a year. These inspections shall occur before and after each flood season, allowing sufficient time for the completion of any maintenance measures needed. The Superintendent shall make the inspections to be certain that attention is being paid to the following:

A. The gates shall be checked for alignment and seating.

B. The pivots shall be free of any stiff or binding action.

C. The gates shall not be jammed in an open position by debris or other obstructions; they shall be thoroughly cleaned so that they swing freely to a true closure. If any parts of the gates have been damaged or broken, they shall be replaced with new parts.

D. The flap gates shall be lubricated at least twice a year, as stated above with an environmentally safe lubricant as suggested by the manufactures.

E. There shall be no trash or sediment deposits that can interfere with movement of the gates or the flow of water.

F. Excessive vegetal growth shall not be permitted in front of or around the structure to insure a complete opening of the outlet structures.

G. Immediate steps shall be taken to repair damage, replace missing or broken parts, or correct adverse conditions disclosed by inspections.

4-08. Slide Gate Maintenance. Slide gates shall be examined, lubricated, and trial operated at least twice a year to ensure proper functioning. These inspections shall take place before and after each flood season. Inspections shall be made by the Superintendent to be certain that

attention is being paid to the following:

A. Flap gates and adjacent outlet structures are kept clear and that care is being taken to prevent the accumulation of trash, drift debris, and sediment on or near the structures.

B. Exposed gate seal surfaces are clean and free of rocks and debris and that gates come to a true closure against the bottom seal.

C. Slide gates shall be free of corrosion.

D. Excessive vegetation growth shall not be permitted in front of or around the structures.

E. Slide gates shall be lubricated at least twice a year, as stated above, with an environmentally safe lubricant as suggest by the manufactures.

F. Immediate steps shall be taken to repair damage, replace missing or broken parts, or correct adverse conditions disclosed by inspections.

4-09. Slide Gate Operation. The local sponsor is responsible for opening and closing the slide gates as pending conditions may facilitate. They should be operated as follows:

A. When the water surface elevation of the river reaches a height which is equal to or greater than the elevation of the bottom of the flap gate opening, the slide gate should be manually closed.

B. At all other times, the slide gates should remain open in order to alleviate interior ponding.

4-10. Relief Wells. Two relief wells were installed to provide a reduction in uplift forces near the toe of the embankment. Proper maintenance of the relief wells is essential to the continual functioning of the wells. A plan for the inspection, monitoring, evaluation and maintenance of the wells is essential. Water levels of relief wells that flow infrequently or remain dry should be observed on an annual basis, preferably prior to the normal high water season. Read water levels every three months for wet wells or when any ground water is detected. The procedure for taking readings is:

(1) Unlock and open lid covering the well.
(2) Check water level indicator for proper operation by inserting sensor probe in

a container of water.

(3) Dry sensor probe and lower into the pipe. Based on the initial depth indicated, lower the probe again to a depth a few feet above the free water surface.

(4) Slowly lower the probe until contact with water. Record the depth to the nearest tenth of a foot.

(5) Note that condensation forms on the walls of the well. This will tend to collect on the probe and falsely indicate that water contact has been made. Shake the lead wire and probe until the indicator needle stops fluctuating.

(6) After each reading, dry the probe thoroughly. Replace the well lid and lock.

(7) After use, the probe & instrument should be cleaned, dried and stored.

Any flow from the relief wells should be recorded with the date and correlated with pool elevation. The amount of sediment in the wells should be recorded yearly. Pumping tests should be conducted every five years to determine specific capacity and well efficiency. If there is a reduction in the capacity accompanied by an increase in the observation well water level or a decrease in efficiency of 20 percent or more from the initial pumping test, the relief well should be redeveloped by mechanical or chemical methods. Mechanical methods include water jetting, block surging, over pumping and blow out with compressed air. Chemical methods include the use of various acids, chelating agents, chlorine, hypochlorites, detergents, and hot water or steam. All additives to the relief wells should comply with the laws and regulations of applicable permitting agencies. Results of annual inspections and readings of relief wells shall be sent to the District Engineer.

Proper maintenance includes removing sand or other material that accumulates in and around flap gates of outlets. Outfall ditches and bank slopes should be properly maintained in the vicinity of any horizontal outlets. The area which extends to about five feet beyond the wells should be kept free from weeds, trash and debris to allow for inspection and servicing.

4-11. <u>Mitigation Plantings Maintenance</u>. Responsibility for the maintenance of the vegetation on mitigation areas waterward of the levee, is also transferred to the City of Grand Junction. Mitigation plantings are for the purpose of mitigating fish and wildlife damages caused by the project. The following items address the responsibilities of the City of Grand Junction in maintaining acceptable site and plant conditions that will not impede vegetative growth.

A. Protect and preserve all vegetation within the mitigation area, including vegetative growth as it □volunteers□ throughout the life of the project.

B. Throughout the life of the project, replant and replace all vegetation lost due to vandalism, fire, flooding, bank erosion, and negligent maintenance practices.
Replacement of waterward plantings will not be required where plant loss occurred to normal stream alteration and where such alteration in terrain was significant and replanting is deemed impractical.

C. No removal of vegetation from the mitigation area shall occur without prior approval from the local sponsor. If vegetation is removed from the mitigation area, an equal number of the same species will be replanted in the mitigation area by the City of Grand Junction for the first three year maintenance period.

D. Preserve all existing trees within the mitigation area. Pruning and removal is to be limited to the minimum necessary to remove inured limbs and branches, and those trees which directly interfere with levee or revetment maintenance.

E. General weed control within the mitigation area is not desirable as it could cause more destruction to the desirable vegetation that the benefits received by its eradication. Whenever weed control is necessary, care shall be taken to ensure that only the targeted plant is affected.

SECTION V - COMBATING FLOODS

5-01. Suggested Methods. Most of the methods described herein have been developed during many years of experience with the various problems that often arise during periods of high water. They are not intended to restrict the Superintendent, or others concerned, to a rigid set of rules for every condition that may arise. They should be considered general guides to procedures that have been effective during past floods, and in themselves or with modifications indicated by an ongoing emergency, would probably be effective in the future.

The following methods are primarily concerned with the earthen portions of the levee system. If problems not covered by these suggestions arise where the Superintendent is in doubt as to the procedure to be taken, he will be expected to consult the State Department of Water Resources and follow standard engineering practices in meeting the situation.

It should be noted that it is much safer to be over-prepared for a □flood fight□ than it is to find at the last moment that preparations were incomplete or unsatisfactory. Confidence of the persons and firms protected is a valuable asset that should not be carelessly lost through inefficient operation of the protection system in time of emergency.

5-02. Inspections. Immediately upon receipt of information that high water is imminent, local interests responsible for maintenance should form a skeleton organization, capable of quick expansion, and assign individuals (Work Supervisors) to have charge of definite reaches of the levee. As his initial activity, each Supervisor should go over his entire sector and parts of adjacent sectors, making a detailed inspection, particularly with reference to the following matters:

A. Sector limits; ascertain that the dividing line between sectors is plainly determined and, if necessary, marked;

B. Condition of levee and recent repairs;

C. Condition of culverts, flap gates;

D. Transportation facilities; roads, rail and water communications;

E. Material supply; quantity, location, and condition;

F. Communications; locate and check all necessary telephones in the sector.

5-03. Preliminary Activities. After the initial inspection has been made, each Work Supervisor should recruit a labor crew and provide it with tools such as shovels, axes, wheelbarrows, etc. In

addition, bulldozers, scrapers, trucks, etc. should be located and made ready for use in case of an emergency. Immediate action should be taken to perform the following work:

A. Fill holes or washes in the levee crown, slopes, and landside berms. Where new construction has been completed during the year, rain washes and deep gullies may have developed. While the levee is new, preparations should be made in advance to combat wave wash along the exposed reaches.

B. Repair gaps where road crossings have been worn down and the levee is below grade. In filling the road crossings, it may be necessary to obtain material from landside borrow pits, in which case excavation of the material should be kept at least 50 feet from the toe of the levee. Any filling done in this connection should be tamped in place and, if in an exposed reach subject to wave wash, the new station should be faced with bags of sand.

C. Repair and close all flap gates on culverts and see that they are seated properly before they are covered with flood waters.

D. Ascertain that all roads to and along the levee are in a good state of repair. The Superintendent should obtain assistance from the city and/or county road forces to have all roads put in first-class condition.

E. Locate necessary tools and materials (sacks, sandbags, brush, lumber, lights, etc.), and distribute and store the same at points where active maintenance is anticipated.

F. Check and obtain repair of all telephone lines necessary for operation; obtain lists of all team forces, motorboats, motor cars, and truck transportation that can be made available.

G. Make thorough arrangements with reliable citizens of the community for the supply of transportation, subsistence, and shelter for the necessary labor.

H. Remove all dynamite and explosives of any kind from the vicinity of the levee.

5-04. Levees. A levee is in danger whenever there is water against it. This danger is directly proportional to the height of the water, the duration of the flood stage, and the intensity of either the current or wave action. The danger is inversely proportional to the cross-sectional area of the levee, the levee's height, and the degree of maintenance. A well-constructed levee of proper section should, if maintained and not overtopped, hold through any major flood. However, serious damages and loss of life may result from a break. Foundation troubles result in sand boils or a sinking levee, and the local use of unsatisfactory materials causes slides and sloughs. However, such threatened failures can be met if prompt action is taken and proper methods of treatment are used. Wave wash is to be expected whenever the levee is exposed to a wide stretch

of open water and is serious if permitted to continue over a considerable length of time.

5-05. Sand Boils. These danger spots are serious if discharging material. The common method of controlling sand boils consists of walling up a watertight sack ring around the boil up to a height necessary to reduce the velocity of flow to a point at which material is no longer discharging from the boil (see EXHIBIT G). The sack ring around the boil should be large enough to protect the defective area immediately surrounding the boil. If several boils of sufficient force to displace material are observed, a sack sub-levee may be built around the entire nest of boils, rising to such a height that none of the boils will discharge with enough force to displace any material.

5-06. Wave Wash. The Superintendent and Work Supervisor should study the levee beforehand to determine the possibility of wave wash. All such reaches should be located well in advance and for use in an emergency, a reserve supply of filled sacks and rolls of polyethylene sheeting canvas should be kept on board flats. If the slope is well sodded, a storm of an hour's duration should cause very little damage. During periods of high wind and high water, experienced personnel should observe where the washouts are beginning by sounding or by prodding along the submerged slope with a rod. Sections of canvas or polyethylene sheeting should be placed over the washed area, as shown on EXHIBIT G. As an alternative, filled sacks should be placed in the cut in an effective manner and as soon as possible. The filled sacks should be laid in sections of sufficient length to give protection well above the anticipated rise. Bagging as just suggested, must be thoroughly weighted down to be effective. EXHIBIT G shows a movable type of wave wash protection also used with good results. Its advantage is that it can be rapidly built at any convenient place and easily set in place on the job.

5-07. Scour. A careful observation should be made of the waterside of the levee at all localities where a current of more than two feet per second is observed, or where profiles show a high water gradient of two feet per mile or greater. Scours may be found near the ends of old levee dikes, road crossing ramps and places where pipes, sewers or other structures penetrate the levee. All scours should be carefully observed to determine the necessity and adequacy of repairs to be accomplished. An approved method to control scour is to construct deflection dikes using brush, lumber, filled sacks, stones, or combinations of such and securing with wire and stakes. (See EXHIBIT G.)

5-08. Topping. The levee is to be continuously maintained at project design grade. If any reaches are determined to be below design grade, emergency topping should be undertaken at once to provide design grade, as follows:

A. Sandbag Topping.

Material filled sacks may be used to raise the crown of the levee about three feet. The sacks should be laid stretcher-wise or along the levee for the first layer, crosswise for the second layer, and so on. Sacks should be lapped at least 1/3 either way and well fitted into place. When

properly sacked and tamped, one sack will give about three to four inches of topping. If gravel is available, it should be used for front facing to avoid washing out. (See EXHIBIT G)

B. Lumber and Sandbag Topping.

This is the most commonly used method for raising low reaches in emergencies. In putting on this topping, as well as other toppings, a careful line of levels should be run and grade stakes set in advance. 2" x 4" x 6' stakes should then be driven on the waterside of the crown six feet apart, and 1" x 12" boards nailed to landside of the stakes. This wall, backed with a single tier of sacks, will hold out at least one foot of water. If a second foot is necessary, the layers of sacks will have to be increased in number and reinforced. The stakes should be driven 3 feet in the ground, and should project out 3 feet, thus providing, in extreme cases, a 3-foot topping if properly braced behind with sacks and earth. In some instances, it may be practical to back up the planking with tamped earth obtained in the vicinity in lieu of the sacks, as shown on Exhibit G.

C. Mud Box Levee.

Mud boxes consist of two parallel wooden walls placed near the waterside of the levee crown or a berm and filled with available material. When constructed on a wide levee crown, it may permit a portion of that crown to remain as a limited roadway. Use mud boxes when fill material has a soupy consistency; the inner face of the wall should first be lined with canvas or polyethylene sheeting. (See EXHIBIT G.) Boxes with smaller dimensions than illustrated may be constructed when necessitated by limited right-of-way or materials; however, the box measurements should be determined by the same ratio as that of a box 24" high by 30" wide.

5-09. Transportation. In instances where it is necessary to send equipment over roads that are impassable due to mud or sand, their passage may be provided by the use of a plank road or by means of steel or wire mats. Telephone or radio communication should be provided along dangerous stretches of the levee when travel or other satisfactory means of communications cannot be maintained.

5-10. Disaster Relief. It is the responsibility of local, state and municipal authorities supported by and/or working in connection with the American Red Cross to adopt measures for the relief of flood disaster victims. Relief measures can be undertaken by the Department of the Army through its Army Area Commander under existing Army Regulations, but such measures will be undertaken only as a last resort in extreme cases and under compelling circumstances where local resources are clearly inadequate to cope with the situation.

5-11. Technical Assistance. During a flood alert, the Corps of Engineers has three major tasks: first, to give local authorities the benefit of the Corps' flood fighting experience; second, to

answer requests for assistance in flood fighting received through the Department of Water Resources; and third, in cooperation with the Department, to assist local agencies in planning maintenance of flood control works and preparation for flood emergencies. The authority granted under Code 910-200 of ER 500-1-1, □Emergency Operations,□ applies to emergency flood fighting. This authority allows divisions/districts to furnish required assistance in support of other agencies and by supplementing local resources as appropriate. Corps assistance may include the following:

A. Furnishing technical advice and assistance;

B. Furnishing flood fighting materials;

C. Hiring of equipment and operators for flood fighting operations;

D. Removal of log or debris jams that are blocking stream flow and causing flooding of communities.

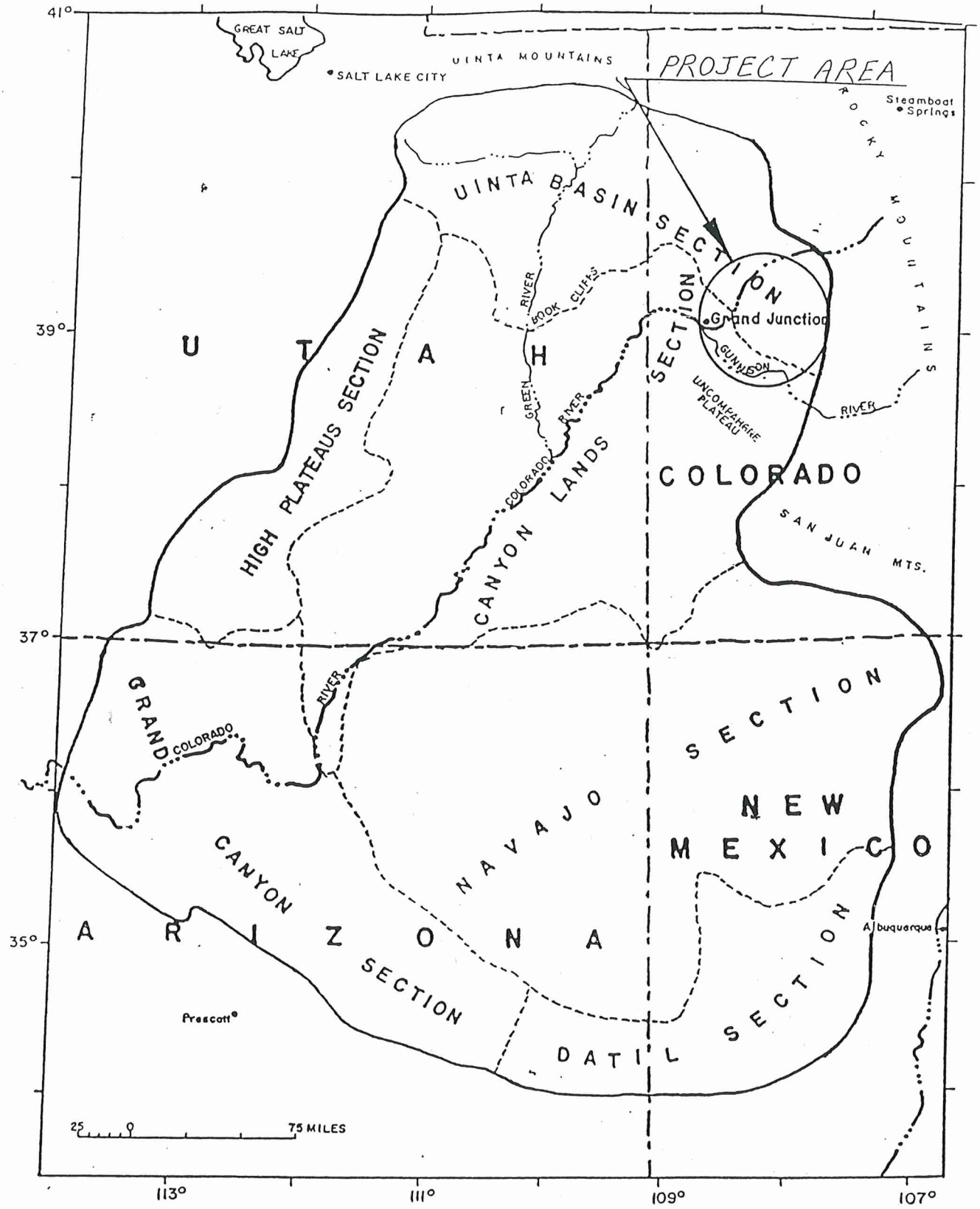
During the emergency situation, Code 910-200 funding will be used when materials are purchased for issue. These funds will also be used to replace items issued from disaster preparedness and other stocks when local interests are not able to provide replacements. All unused stocks on loan will be returned to the Corps when the operation is complete. Consumed supplies will be replaced in kind or paid for by local interests to the extent considered feasible and practical by the Division or District Commander.

5-12. Government Equipment. The District Engineer is authorized to use or loan Government property and plant in cases of an extreme emergency where life is in danger and there is no opportunity to secure prior authority for such use. The authority also extends to saving of property where no suitable private equipment is available, provided such use is without detriment to the Government.

5-13. Premeditated Damages. In the event of an extraordinary flood requiring a flood fight over long stretches of levee on both sides of the channel there is a possibility that threatened landowners may be tempted to relieve the strain by premeditated breaching of the opposite levee. Local interests should continually guard against such premeditated damage to the levees. Personnel of the U.S. Army Corps of Engineers, whether military or civilian are not vested with any civil police authority in performance of their engineering duties and they will not attempt to exercise any such authority. The responsibility for protecting flood control works against sabotage, acts of depredation, or other unlawful acts rests with the local interests through local and State Government agencies. In the event that local law enforcement agencies prove inadequate, local interests, as provided by law, can request the aid of state forces and the aid of Federal Troops if additional support becomes necessary.

EXHIBIT A

PLATES 1 THROUGH 5



Index map showing the Colorado Plateau Geomorphic Province and its six sections. (Modified from C.B. Hunt 1956, Cenozoic Geology of the Colorado Plateau). The levee project is in the northeast corner of Canyonlands Section in Grand Junction, Colorado.

EXHIBIT A PLATE 1

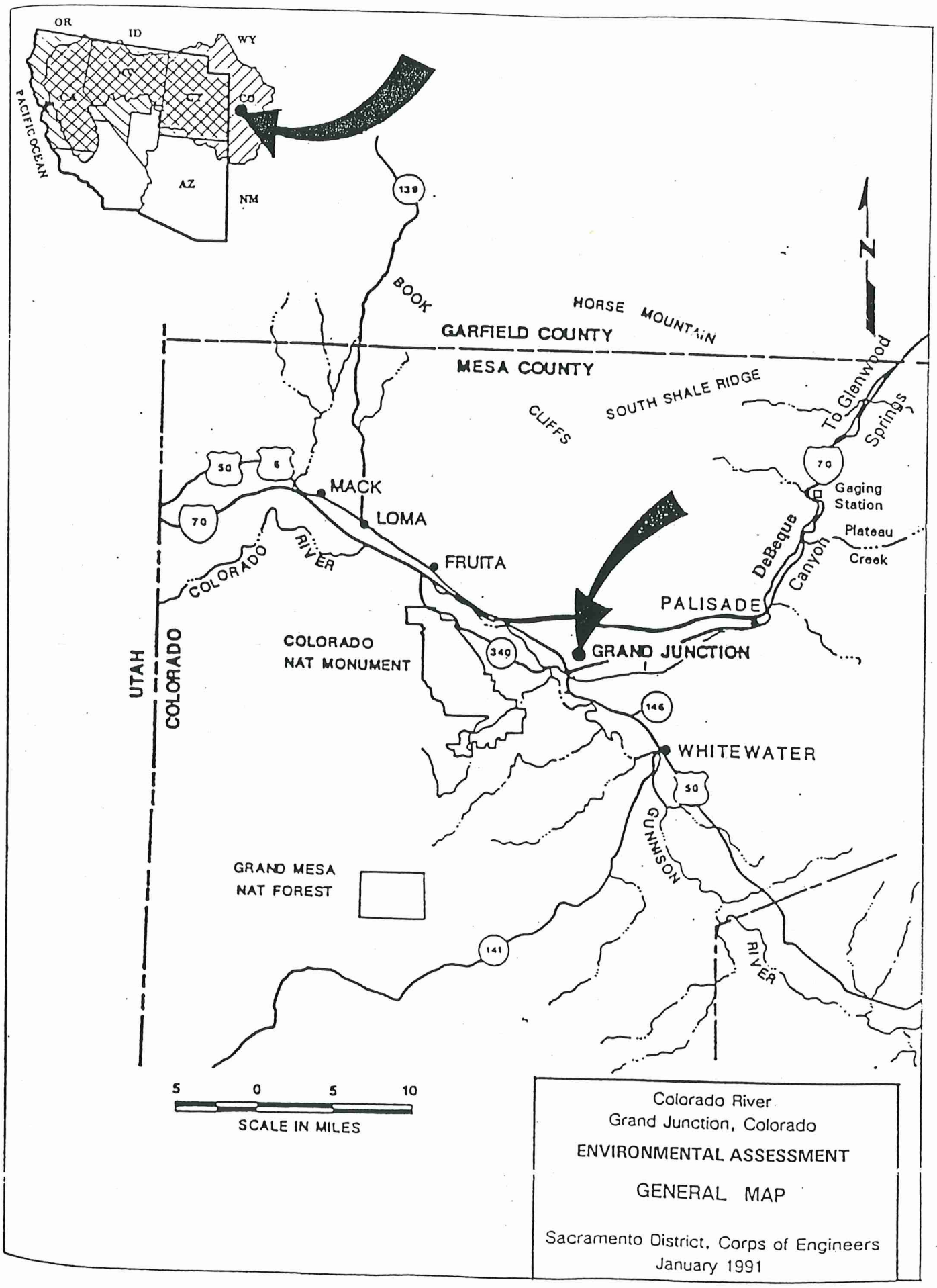
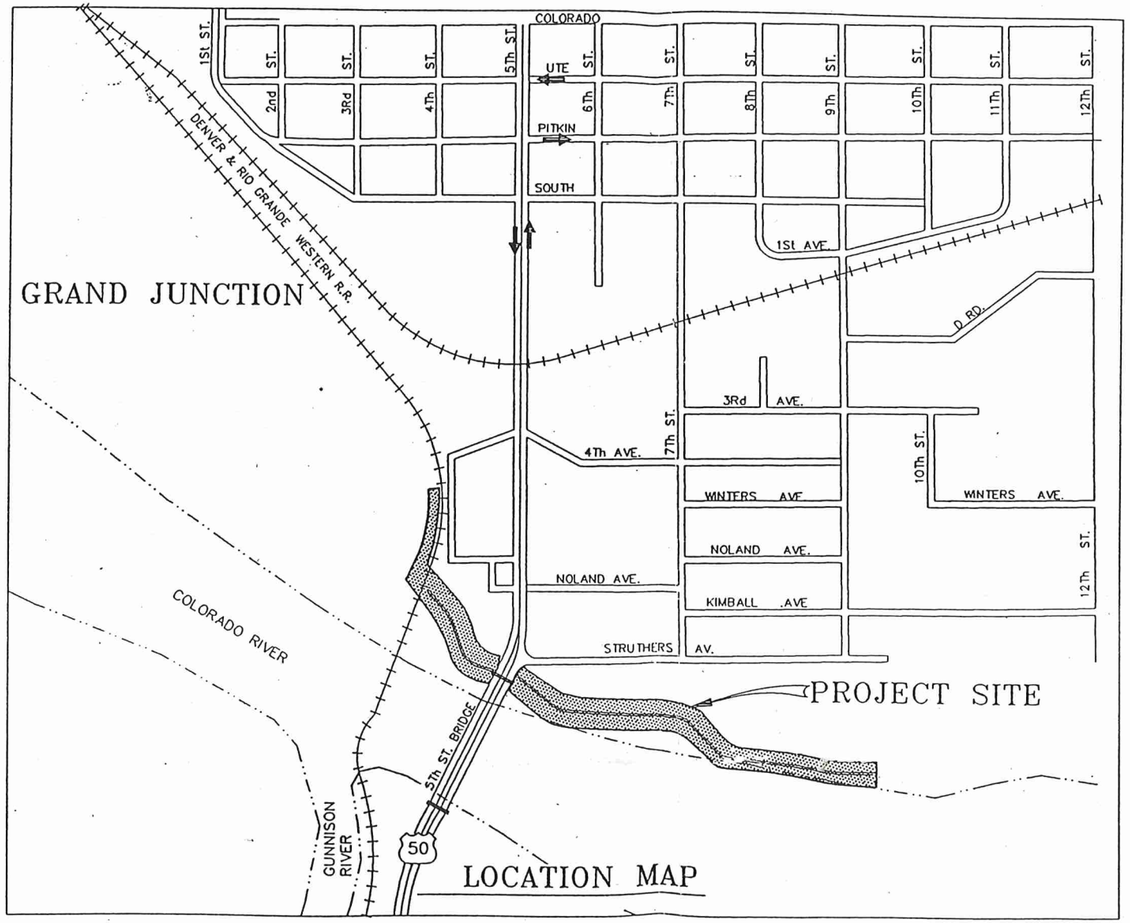


EXHIBIT A PLATE 2

GRAND JUNCTION, COLORADO
LEVEE PROJECT

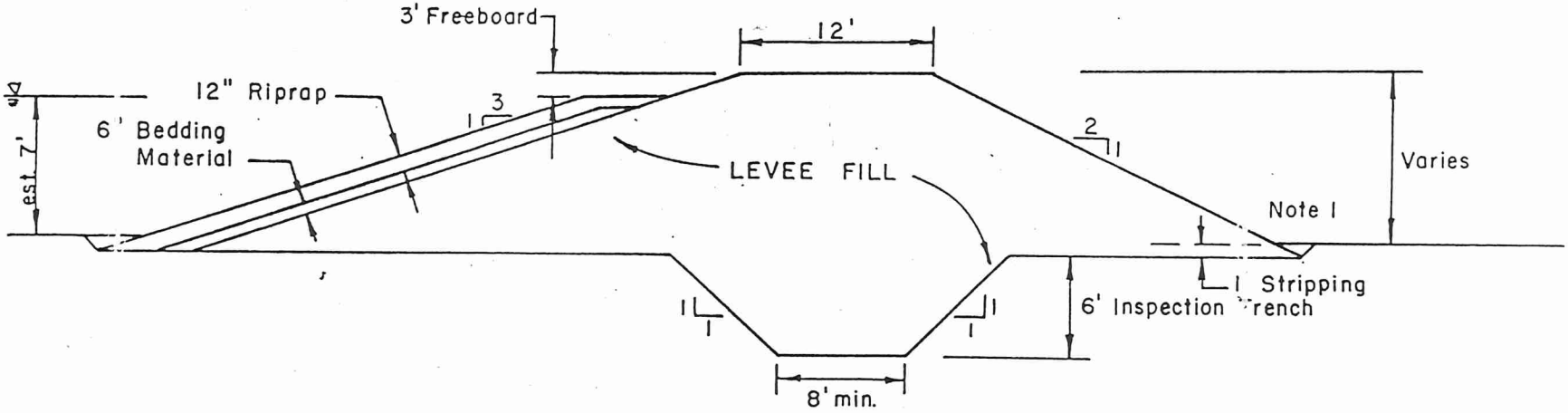


DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

GRAND JUNCTION COLORADO

LEVEE PROJECT

LOCATION MAP



Note 1. Berm or relief well system to be designed during Preconstruction Engineering & Design

Scale: 1" = 10'

GRAND JUNCTION, COLORADO
SECTION 205
FEASIBILITY STUDY

FLOOD CONTROL LEVEE

TYPICAL SECTION

EXHIBIT A PLATE 4

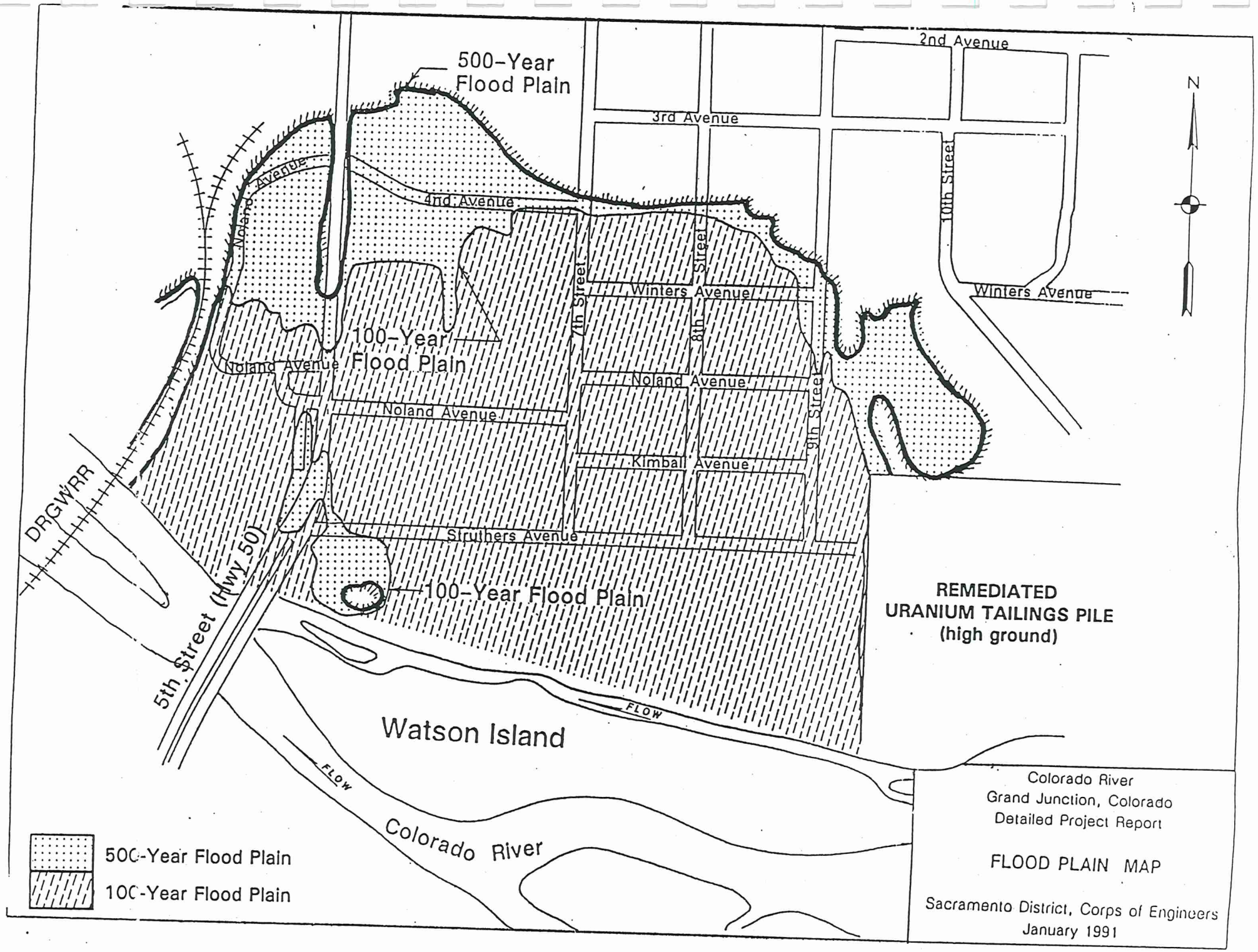


EXHIBIT A PLATE 5

EXHIBIT B

FEDERAL FLOOD CONTROL REGULATIONS

TITLE 33—NAVIGATION AND NAVIGABLE WATERS

Chapter II — Corps of Engineers, Department of the Army

PART 208 — FLOOD CONTROL REGULATIONS

AUTHORITY: § 208.10 issued under Sec. 7, 58 Stat. 890; 33 U.S.C. 709.

§ 208.10 *Local flood protection works; maintenance and operation of structures and facilities* — (a) *General.* (1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of the Army, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the "Superintendent," who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities.

(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the Department of the Army or his authorized representative that such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

(6) It shall be the duty of the Superintendent to submit a semiannual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

(7) The District Engineer or his authorized representatives shall have access at all times to all portions of the protective works.

(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods.

(10) The Department of the Army will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under this part.

(b) *Levees* — (1) *Maintenance.* The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

(i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;

(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;

(iii) No seepage, saturated areas, or sand boils are occurring;

(iv) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;

(v) Drains through the levees and gates on said drains are in good working condition;

(vi) No revetment work or riprap has been displaced, washed out, or removed;

(vii) No action is being taken, such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;

(viii) Access roads to and on the levee are being properly maintained;

(ix) Cattle guards and gates are in good condition;

(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;

(xi) There is no unauthorized grazing or vehicular traffic on the levees;

(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days; and such intermediate times as may be necessary to insure the best possible care of the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent.

(2) *Operation.* During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

(i) There are no indications of slides or sloughs developing;

(ii) Wave wash or scouring action is not occurring;

(iii) No low reaches of levee exist which may be overtopped;

(iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section.

(c) *Flood walls.* — (1) *Maintenance.* Periodic inspections shall be made by the Superintendent to be certain that:

(i) No seepage, saturated areas, or sand boils are occurring;

(ii) No undue settlement has occurred which affects the stability of the wall or its water tightness;

(iii) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;

(iv) The concrete has not undergone cracking, chipping, or breaking to an extend which might affect the stability of the wall or its water tightness;

(v) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;

(vi) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;

(vii) No bank caving conditions exist riverward of the wall which might endanger its stability;

(viii) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged.

Such inspections shall be made immediately prior to the beginning of the flood season, immediately following each major high water period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice.

(2) *Operation.* Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolith joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall.

(d) *Drainage structures*—(1) *Maintenance.* Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on drainage structures shall be examined, oiled, and trial operated at least once

every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once each year. Periodic inspections shall be made by the Superintendent to be certain that:

(i) Pipes, gates, operating mechanism, riprap, and headwalls are in good condition;

(ii) Inlet and outlet channels are open;

(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

(iv) Erosion is not occurring adjacent to the structure which might endanger its water tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections.

(2) *Operation.* Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition.

(e) *Closure structures* – (1) *Maintenance.* Closure structures for traffic openings shall be inspected by the Superintendent every 90 days to be certain that:

(i) No parts are missing;

(ii) Metal parts are adequately covered with paint;

(iii) All movable parts are in satisfactory working order;

(iv) Proper closure can be made promptly when necessary;

(v) Sufficient materials are on hand for the erection of sand bag closures and that the location of such materials will be readily accessible in times of emergency.

Tools and parts shall not be removed for other use. Trial erections of one or more closure structures shall be made once each year, alternating the structures chosen so that each gate will be erected at least once in each 3-year period. Trial erection of all closure structures shall be made whenever a change is made in key operating personnel. Where railroad operation makes trial erection of a closure structure infeasible, rigorous inspection and drill of operating personnel may be substituted therefor. Trial erection of sand bag closures is not required. Closure materials will be carefully checked prior to and following flood periods, and damaged or missing parts shall be repaired or replaced immediately.

(2) *Operation.* Erection of each movable closure shall be started in sufficient time to permit completion before flood waters reach the top of the structure sill. Information regarding the proper method of erecting each individual closure structure, together with an estimate of the time required by an experienced crew to complete its erection will be given in the Operation and Maintenance Manual which will be furnished local interests upon completion of the project. Closure structures will be inspected frequently during flood periods to ascertain that no undue leakage is occurring and that drains provided to care for ordinary leakage are functioning properly. Boats or floating plant shall not be allowed to tie up to closure structures or to discharge passengers or cargo over them.

(f) *Pumping plants* – (1) *Maintenance.* Pumping plants shall be inspected by the Superintendent at intervals not to exceed 30 days during flood seasons and 90 days during off-flood seasons to insure that all equipment is in order for instant use. At regular intervals, proper measures shall be taken to provide for cleaning plant, buildings, and equipment, repainting as necessary, and lubricating all machinery. Adequate supplies of lubricants for all types of machines, fuel for gasoline or diesel powered equipment, and flash lights or lanterns for emergency lighting shall be kept on hand at all times. Telephone service shall be maintained at pumping plants. All equipment, including switch gear, transformers, motors, pumps, valves, and gates shall be trial operated and checked at least once every 90 days. Megger tests of all insulation shall be made whenever wiring has been subjected to undue dampness and otherwise at intervals not to exceed one year. A record shall be kept showing the results of such tests. Wiring disclosed to be in an unsatisfactory condition by such tests shall be brought to a satisfactory condition or shall be promptly replaced. Diesel and gasoline engines shall be started at such intervals and allowed to run for such length of time as may be necessary to insure their serviceability in times of emergency. Only skilled electricians and mechanics shall be employed on tests and repairs. Operating personnel for the plant shall be present during tests. Any equipment removed from the station for repair or replacement shall be returned or replaced as soon as practicable and shall be trial operated after reinstallation. Repairs requiring removal of equipment from the plant shall be made during off-flood seasons insofar as practicable.

(2) *Operation.* Competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent. The operator shall thoroughly inspect, trial operate, and place in readiness all plant equipment. The operator shall be familiar with the equipment manufacturers' instructions and drawings and with the "Operating Instructions" for each station. The equipment shall be operated in accordance with the above-mentioned "Operating Instructions" and care shall be exercised that proper lubrication is being supplied all equipment, and that no overheating, undue vibration or noise is occurring. Immediately upon final recession of flood waters, the pumping station shall be thoroughly cleaned, pump house sumps flushed, and equipment thoroughly inspected, oiled and greased. A record or log of pumping plant operation shall be kept for each station, a copy of which shall be furnished the District Engineer following each flood.

(g) *Channels and floodways* – (1) *Maintenance.* Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth;

(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;

(iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;

(iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred;

(v) Riprap sections and deflection dikes and walls are in good condition;

(vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary.

(2) *Operation.* Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or by wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired.

(h) *Miscellaneous facilities* – (1) *Maintenance.* Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damaged or unserviceable parts shall be repaired or replaced without delay. Areas used for ponding in connection with pumping plants or for temporary storage of interior run-off during flood periods shall not be allowed to become filled with silt, debris, or dumped material. The Superintendent shall take proper steps to prevent restriction of bridge openings and, where practicable, shall provide for temporary raising during floods of bridges which restrict channel capacities during high flows.

(2) *Operation.* Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor. (Sec. 3, 49 Stat. 1571, as amended; 33 U.S.C. 701C) [9 F.R. 9999, Aug. 17, 1944; 9 F.R. 10203, Aug. 22, 1944]

EXHIBIT C

LOCAL COOPERATION AGREEMENT

UNITED STATES ARMY CORPS OF ENGINEERS

CONTINUING AUTHORITIES PROGRAM

SECTION 205
SINGLE PURPOSE
STRUCTURAL
FLOOD CONTROL PROJECT

****

LOCAL COOPERATION AGREEMENT
BETWEEN
THE DEPARTMENT OF THE ARMY

AND

THE CITY OF GRAND JUNCTION, COLORADO

FOR THE CONSTRUCTION OF THE

GRAND JUNCTION LEVEE PROJECT

THIS AGREEMENT, entered into this 8th day of April, 1994, by and between the DEPARTMENT OF THE ARMY (hereinafter referred to as the "Government"), acting by and through the District Engineer for the Sacramento District, U.S. Army Corps of Engineers and the City of Grand Junction, Colorado (hereinafter referred to as the Local Sponsor), acting by and through the City Manager.

WITNESSETH, THAT:

WHEREAS, the authority for the construction of the Grand Junction Levee Project at the north overbank of the Colorado River between the Denver and Rio Grande Western Railroad Bridge and the Uranium Tailings Pile near 9th Street (hereinafter referred to as the "Project", as defined in Article I.a. of this Agreement), is contained in Section 205 of the Flood Control Act of 1948, as amended, 33 U.S.C. 701s; and

WHEREAS, Section 205 of the Flood Control Act of 1948, as amended, 33 U.S.C. 701s, limits the amount the Federal Government may expend on a single project to $5,000,000; and,

c. The term "period of construction" shall mean the time from the advertisement of the first construction contract to the time of acceptance of the Project by the Contracting Officer.

d. The term "Contracting Officer" shall mean a representative of the Government with the authority to enter into, administer, and/or terminate contracts and make related determinations and findings.

e. The term "highway" shall mean any highway, thoroughfare, roadway, street, or other public road or way.

f. The term "relocations" shall mean alterations, modifications, lowering or raising in place, and/or new construction related to, but not limited to, existing railroads, highways, bridges, railroad bridges and approaches thereto, buildings, pipelines, public utilities (such as municipal water and sanitary sewer lines, telephone lines, and storm drains), aerial utilities, cemeteries, and other facilities, structures, and improvements determined by the Government to be necessary for the construction, operation and maintenance of the Project.

g. The term "fiscal year" shall mean one fiscal year of the United States Government, unless otherwise specifically indicated. The Government fiscal year begins on October 1 and ends on September 30.

h. The term "involuntary acquisition" shall mean the acquisition of lands, easements, and rights-of-way by eminent domain.

i. The term "functional portion of the Project" shall mean a completed portion of the Project as determined by the Contracting Officer to be suitable for tender to the Local Sponsor to operate and maintain in advance of completion of construction of the entire Project.

j. Words which appear between brackets, whether they appear between or within lines of text, do not constitute a part of this Agreement. They are intended only as instructions regarding the proper completion of this Agreement.

ARTICLE II- OBLIGATIONS OF PARTIES

a. The Government, subject to and using funds provided by the Local Sponsor and appropriated by the Congress of the United States, shall expeditiously construct the Project (including relocations of railroad bridges and approaches thereto), applying those procedures usually followed or applied in Federal projects, pursuant to Federal laws, regulations, and policies. To the extent possible, the Local Sponsor shall be

h. The Local Sponsor agrees to participate in and comply with applicable Federal flood plain management and flood insurance programs.

i. The Local Sponsor shall comply with all items of local cooperation set out in the aforementioned report entitled Colorado River, Grand Junction, Colorado, Section 205 Detailed Project Report for Flood Control prepared by the Sacramento District, dated July 1992, and approved by South Pacific Division on 16 November 1992.

ARTICLE III- LANDS, FACILITIES, AND PUBLIC LAW 91-646 RELOCATION ASSISTANCE

a. The Local Sponsor shall furnish to the Government all lands, easements, and rights-of-way, including suitable borrow and dredged material disposal areas, as may be determined by the Government to be necessary for the construction, operation, and maintenance of the Project, and shall furnish to the Government evidence supporting the Local Sponsor's legal authority to grant rights-of-entry to such lands. The necessary lands, easements, and rights-of-way may be provided incrementally, but all lands, easements, and rights-of-way determined by the Government to be necessary for work to be performed under a construction contract must be furnished prior to the advertisement of the construction contract.

b. The Local Sponsor shall provide or pay to the Government the cost of providing all retaining dikes, wasteweirs, bulkheads, and embankments, including all monitoring features and stilling basins, that may be required at any dredged material disposal areas necessary for construction of the Project.

c. Upon notification from the Government, the Local Sponsor shall accomplish or arrange for accomplishment at no cost to the Government all relocations (excluding railroad bridges and approaches thereto) determined by the Government to be necessary for construction of the Project.

d. The Local Sponsor shall comply with all the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way for construction and subsequent operation and maintenance of the Project, and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act. The Local Sponsor shall provide such documentation as the Contracting Officer requires to demonstrate compliance.

b. The costs of relocations which will be included in total project costs and credited towards the Local Sponsor's share of total project costs shall be that portion of the actual costs as set forth below, and approved by the Government:

1. Highways and Highway Bridges: Only that portion of the cost as would be necessary to construct substitute bridges and highways to the design standard that the State of Colorado would use in constructing a new bridge or highway under similar conditions of geography and traffic loads.

2. Utilities and Facilities (including railroads): Actual relocation costs, less depreciation, less salvage value, plus the cost of removal, less the cost of betterments. With respect to betterments, new materials shall not be used in any alteration or relocation if materials of value and usability equal to those in the existing facility are available or can be obtained as salvage from the existing facility or otherwise, unless the provision of new material is more economical. If, despite the availability of used material, new materials is used, where the use of such new material represents an additional cost, such cost will not be included in total project costs, nor credited toward the Local Sponsor's share.

ARTICLE V- CONSTRUCTION PHASING AND MANAGEMENT

a. To provide for consistent and effective communication between the Local Sponsor and the Government during the period of construction, the Local Sponsor and the Government shall appoint representatives to coordinate on scheduling, plans, specifications, modifications, contracting costs, and other matters relating to construction of the Project. The Local sponsor will be informed of any change in cost estimates.

b. The representatives appointed above shall meet as necessary during the period of construction and shall make such recommendations as they deem warranted to the Contracting Officer.

c. The Contracting Officer shall consider the recommendations of the representatives in all matters relating to construction of the Project, but the Contracting Officer, having ultimate responsibility for construction of the Project, has complete discretion to accept, reject, or modify the recommendations.

e. In the event the Local Sponsor has made cash contributions in excess of 5 percent of total project costs which result in the Local Sponsor's having provided more than its required share of total project costs, the Government shall, no later than 90 calendar days after the final accounting is complete, subject to the availability of appropriations for that purpose, and subject to the Federal cost limitation set out in Article II.f., return said excess to the Local Sponsor; however, the Local Sponsor shall not be entitled to any refund of the five percent cash contribution required pursuant to Article II.c. of this Agreement.

f. If the Local Sponsor's total contribution under this Agreement (including lands, easements, rights-of-way, and relocations, and suitable borrow and dredged material disposal areas provided by the Local Sponsor) exceeds 50 percent of total project costs, the Government shall, subject to the availability of appropriations for that purpose, and subject to the Federal limitation set out in Article II.f., refund the excess to the Local Sponsor no later than 90 calendar days after the final accounting is complete.

ARTICLE VII - DISPUTES

Before any party to this Agreement may bring suit in any court concerning an issue relating to this Agreement, such party must first seek in good faith to resolve the issue through negotiation or other forms of nonbinding alternative dispute resolution mutually acceptable to the parties.

ARTICLE VIII - OPERATION, MAINTENANCE, REPAIR, REPLACEMENT, AND REHABILITATION

a. After the Government has turned the completed Project, or functional portion of the Project, over to the Local Sponsor, the Local Sponsor shall operate, maintain, repair, replace, and rehabilitate the completed Project, or functional portion of the Project, in accordance with regulations or directions prescribed by the Government.

b. The Local Sponsor hereby gives the Government a right to enter, at reasonable times and in a reasonable manner, upon land which it owns or controls for access to the Project for the purpose of inspection, and, if necessary, for the purpose of completing, operating, maintaining, repairing, replacing, or rehabilitating the Project. If an inspection shows that the Local Sponsor for any reason is failing to fulfill its obligations under this Agreement without receiving prior written approval from the Government, the Government will send a written notice to the Local Sponsor. If the Local Sponsor persists in

published in Part 300 of Title 32, Code of Federal Regulations, as well as Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army".

ARTICLE XIII - RELATIONSHIP OF PARTIES

The parties to this Agreement act in an independent capacity in the performance of their respective functions under this Agreement, and neither party is to be considered the officer, agent, or employee of the other.

ARTICLE XIV - OFFICIALS NOT TO BENEFIT

No member of or delegate to the Congress, or resident commissioner, shall be admitted to any share or part of this Agreement, or to any benefit that may arise therefrom.

ARTICLE XV - COVENANT AGAINST CONTINGENT FEES

The Local Sponsor warrants that no person or selling agency has been employed or retained to solicit or secure this Agreement upon agreement or understanding for a commission, percentage, brokerage, or contingent fee, excepting bona fide employees or bona fide established commercial or selling agencies maintained by the Local Sponsor for the purpose of securing business. For breach or violation of this warranty, the Government shall have the right to annul this Agreement without liability, or, in its discretion, to add to the Agreement or consideration, or otherwise recover, the full amount of such commission, percentage, brokerage, or contingent fee.

ARTICLE XVI - TERMINATION OR SUSPENSION

a. If at any time the Local Sponsor fails to make the payments required under this Agreement, the Secretary of the Army shall terminate or suspend work on the Project until the Local Sponsor is no longer in arrears, unless the Secretary of the Army determines that continuation of work on the Project is in the interest of the United States or is necessary in order to satisfy agreements with any other non-Federal interests in connection with the Project. Any delinquent payment shall be charged interest at a rate, to be determined by the Secretary of the Treasury, equal to 150 per centrum of the average bond equivalent rate of the 13-week Treasury bills auctioned immediately prior to the date on which such payment became delinquent, or auctioned immediately prior to the beginning of each additional 3-month period if the period of delinquency exceeds 3 months.

ARTICLE XVIII - CONFIDENTIALITY

To the extent permitted by the laws governing each party, the parties agree to maintain the confidentiality of exchanged information when requested to do so by the providing party.

ARTICLE XIX - HAZARDOUS SUBSTANCES

a. After execution of this Agreement and upon direction by the Contracting Officer, the Local Sponsor shall perform, or cause to be performed, such environmental investigations as are determined necessary by the Government or the Local Sponsor to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 USC 9601-9675, on lands necessary for Project construction, operation, and maintenance. All actual costs incurred by the Local Sponsor which are properly allowable and allocable to performance of any such environmental investigations shall be included in total project costs and cost shared as a construction cost in accordance with Section 103 of Public Law 99-662.

b. In the event it is discovered through an environmental investigation or other means that any lands, easements, rights-of-way, or disposal areas to be acquired or provided for the Project contain any hazardous substances regulated under CERCLA, the Local Sponsor and the Government shall provide prompt notice to each other, and the Local Sponsor shall not proceed with the acquisition of lands, easements, rights-of-way, or disposal areas until mutually agreed.

c. The Government and the Local Sponsor shall determine whether to initiate construction of the Project, or if already in construction, to continue with construction of the Project, or to terminate construction of the Project for the convenience of the Government in any case where hazardous substances regulated under CERCLA are found to exist on any lands necessary for the Project. Should the Government and the Local Sponsor determine to proceed or continue with construction after considering any liability that may arise under CERCLA, as between the Government and the Local Sponsor, the Local Sponsor shall be responsible for any and all necessary clean up and response costs, to include the costs of any studies and investigations necessary to determine an appropriate response to the contamination. Such costs shall not be considered a part of total project costs as defined in this Agreement. In the event that Local Sponsor fails to provide any funds necessary to pay for the clean up and response costs or to otherwise discharge its responsibilities under this paragraph upon direction by the Government, the Government may either terminate or suspend work

CERTIFICATE OF AUTHORITY

I, Dan Wilson do hereby certify that I am the principal legal officer of the City of Grand Junction, Colorado, that the City of Grand Junction, Colorado, is legally constituted public body with full authority and legal capability to perform the terms of the Agreement between the Department of the Army and the City of Grand Junction, Colorado, in connection with the Grand Junction Levee Project, and to pay damages, if necessary, in the event of the failure to perform, in accordance with Section 221 of Public Law 91-611, and that the person(s) who has/have executed this Agreement on behalf of City of Grand Junction, Colorado, has/have acted within their statutory authority.

IN WITNESS WHEREOF, I have made and executed this certification this 30th day of March 19 94.

Dan Wilson

Dan Wilson
City Attorney

EXHIBIT D

INSPECTION CHECKLISTS

INSPECTION CHECKLIST
FOR
LEVEE AND FLOODWAY

Inspector _____ Date _____
Superintendent _____ Sheet No. _____

ITEM	REMARKS
A) Location by levee station	
B) Landside levee conditions	
C) Waterside levee conditions	
D) Evidence of seepage	
E) Channel and Floodway conditions	
F) Extent of vegetative growth	
G) Accumulation of debris and refuse	
H) Condition of riprap	
I) Condition of roadways and ramps	
J) Condition of gates and fences	
K) New construction or encroachment within right-of-way	
L) Measures taken since last inspection	
M) Condition of mitigation plantings	
N) Comments	

INSTRUCTIONS FOR COMPLETING
INSPECTION CHECKLIST FOR LEVEES AND FLOODWAYS

ITEM A) Indicate levee station corresponding to plans of project or, on the downstream channel, the river mile.

ITEM B) Indicate condition of the levee landside embankment and levee crown. Note if there is any settlement, sloughing, loss of grade or erosion on the levee. Indicate amount of settlement to tenths of a foot. Indicate the new slope is sloughing has occured. Indicate extent of erosion if it occured.

ITEM C) Indicate condition of the levee waterside embankment. Note if there is any settlement, sloughing, loss of grade or erosion on the levee. Indicate amount of settlement to tenths of a foot. Indicate the new slope if sloughing has occured. Indicate extent of erosion if it occured. Indicate any evidence of rodent holes and the extent to which it occured.

ITEM D) Indicate any evidence of seepage through the embankment section, such as boils, drainage pipe leaks, etc.

ITEM E) Indicate condition of the channel and the floodway. Note the extent of aggradation or degradation. Indicate any change in channel and floodway grade or alignment. Note amount of sediment buildup such as shoals or extent of scouring.

ITEM F) Note nature, extent and size of vegetal growth within the limits of the flood flow channel.

ITEM G) Note nature and extent of debris and refuse that might interfere with flow capacity of the channel or flood fighting operations. This includes clogging of conduits, interference with gates or bridges and obstructing channel flow.

ITEM H) Indicate condition of riprap. Note if the rock has been deteriorated or damaged. Note any movement of rock or if any erosion has taken place. Note the presence of any vegetal growth through the riprap

ITEM I) Indicate condition of roadways and ramps. Note any changes such as potholes, undulations, or any other damage. Note any inadequacy in surface drainage system.

EXHIBIT E

SEMIANNUAL REPORT FORM

TO: District Engineer
Sacramento District
U.S. Army Corps of Engineers
1325 J Street
Sacramento, CA 95814-2922

(1 May 19___)
(1 Nov 19___)

Dear Sir:

The semi-annual report for the period of (1 May 19___ to 31 October 19___ or 1 November 19___ to 30 April 19___) for the _____project, _____ County, Colorado is as follows:

A) The condition of the mitigation plantings is summarized as follows:

(Superintendent's summary of conditions may be inserted here)

It is our intention to perform (within 6 months) the following maintenance operations in order to repair or correct the conditions indicated above:

(Superintendent's summary of maintenance operations for the following 6 months)

B) During this report period major high water periods (water surface reached or exceeded the toe of the project levee) occurred on the following dates:

STREAM	GAGE STATION	DATE	MAXIMUM ELEVATION

Comments on the behavior of the protective works during such high water periods are as follows:

(Superintendent's log of flood observations)

During the high water stages when the water level reached a height of _____, on the gage or excess thereof (dates)_____, it was necessary to organize and carry out flood operations as follows:

(See Maintenance Manual _____)

C) The inspections have indicated (no) or (the following) encroachments or trespasses upon the project right-of-way.

D) (No) (_____) permits have been issued for (the following improvements) or (construction within) the project right-of-way.

Executed copies of the permit documents issued are transmitted for your files.

E) The status of maintenance measures, indicated in the previous semi-annual report as being required or as suggested by the representatives of the District Engineer, is as follows:

(Statement of maintenance operations, item by item with percent completion)

F) The fiscal statement of the Superintendent's operations for the current report period is as follows:

	Labor	Material	Equipment	Overhead	Total
1. Inspection					
2. Maintenance					
3. Flood Fighting Operations					
TOTAL					

Respectfully submitted,

_____

Superintendent of Works

EXHIBIT F

SAMPLE PERMIT FOR USE OF RIGHT-OF-WAY

PERMIT

_____
(Name of Levee Commission or City)

_____
(Location)

Permission is hereby granted to:

_____ _____
(Name of Firm or Individual) (Address)

TO: (Describe in these spaces the proposal, including kind and type of construction, purpose intended, location by stationing. Indicate passageway provided by means of gates, etc. Use separate sheet if necessary, identifying each by reference herein.)

_____

_____

_____

_____

Provided That:

Upon termination or expiration of this permit (whether by voluntary relinquishment by the grantee, by revocation by the grantor or otherwise) the grantee shall remove all structures, improvements, or appurtenances which may have been erected or constructed under this permit, and shall repair or replace any portion of the flood protection structures or right-of-way which may have been damaged by his operations (including grading and seeding, or sodding, if necessary), to the satisfaction of the grantor.

The structure or operation for which this permit is issued shall be maintained by the grantee in such manner as shall not injure or damage the flood protection structure, or interfere with its operation and maintenance in accordance with regulations of the Secretary of the Army.

The structure or operation covered by this permit may be damaged, removed or destroyed by the grantor in time of flood emergency if such action is determined by the grantor to be necessary in order to preserve life or property or prevent damage or impairment to the use or safety of the flood protection structure, and the grantor shall not be liable to the grantee for such damage or destruction.

Unless otherwise specifically provided herein, this permit may be cancelled at any time by the grantor upon 10 days written notice mailed to the address shown above. During such 10 day period, (or such other period as may be provided herein), the grantee will be permitted to remove any property or improvements installed under this permit, and to repair or replace any damage to the flood protection right-of-way or structures resulting from his use or operations. At the end of such period, the grantor shall have the right to possess and dispose of any such property or improvements remaining upon its right-of-way, and may proceed to repair or replace any such damage, and the grantee herein shall be liable to the grantor for the full cost of such repairs or replacements.

The construction, installation and maintenance of the structure or structures covered by this permit shall be subject to inspection by representatives of the grantor and the United States at all reasonable times.

In the event the work covered by this permit consists of or includes major construction, the cost of inspection thereof by the grantor and/or the United States shall be paid by the applicant.

Grantee agrees that it will not use the area or facilities covered by this permit, or permit such area to be used, for any purpose other than is specifically covered by this permit.

(Use these spaces for special conditions applicable to this permit.)

_____

_____

_____

THIS PERMIT SHALL NOT BE VALID UNTIL APPROVED BY THE DISTRICT ENGINEER, CORPS OF ENGINEERS, U.S. ARMY, OR HIS AUTHORIZED REPRESENTATIVE.

_____ _____ _____
Signature (Grantor) (Title) (Date)

Terms of this permit
are hereby accepted

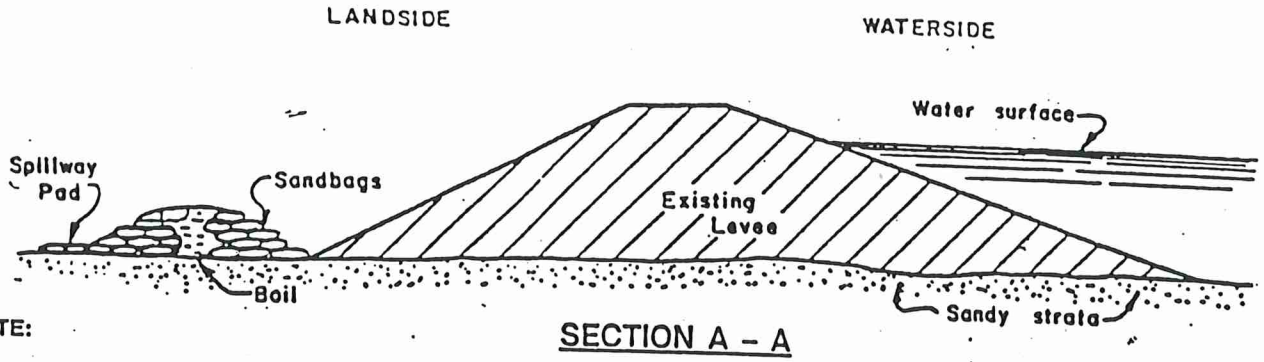
Approved:

_____ _____ _____ _____
Signature (Grantee) (Date) District Engineer (Date)

EXHIBIT F
PAGE 1 OF 1

EXHIBIT G

SEMIANNUAL REPORT FORM



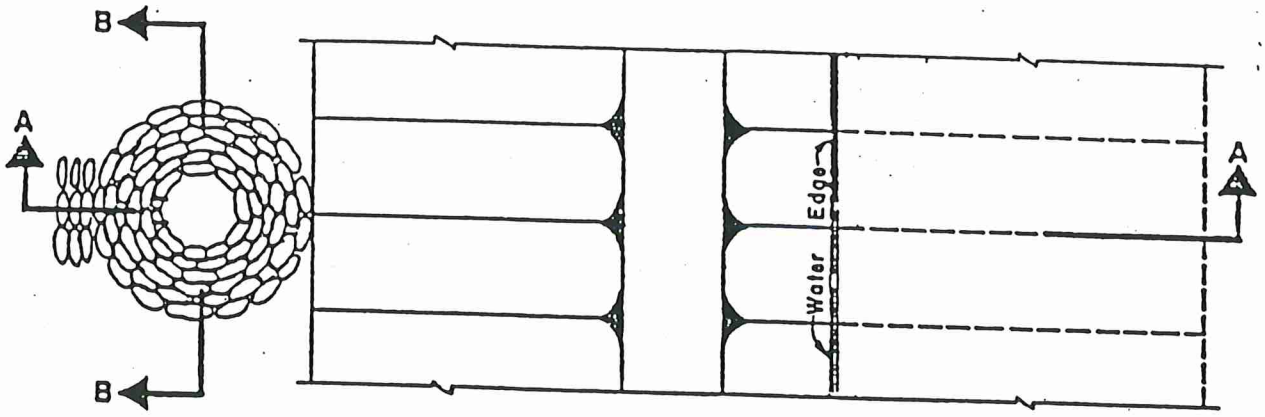
SECTION A – A

NOTE:

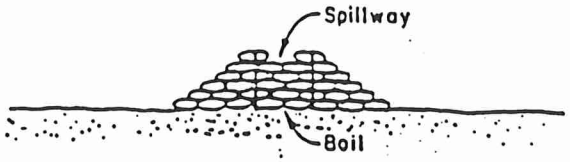
Bottom width to be no less than 1.5 times height.

Be sure to clear sand discharge.

Tie into levee if boil is near toe.



PLAN



SECTION B – B

NOTE:

Do not sack boils which do not put out material.

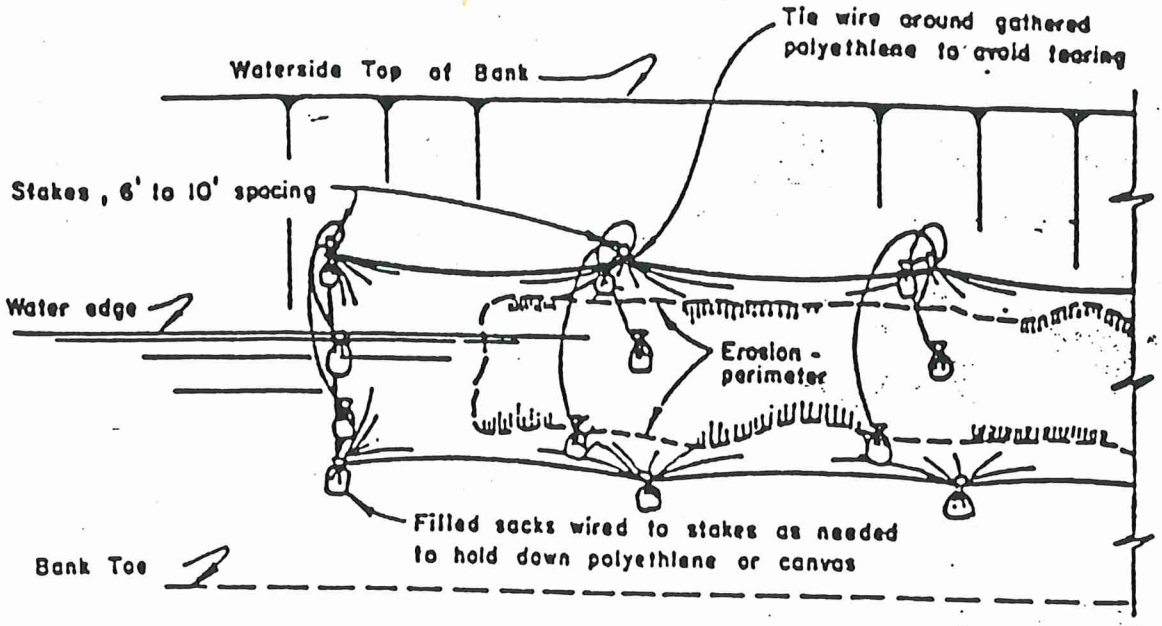
Height of sack loop or ring should be only sufficient to create enough head to slow down flow through boil so that no more material is displaced and boil runs clear.

Never attempt to stop completely the flow through a boil.

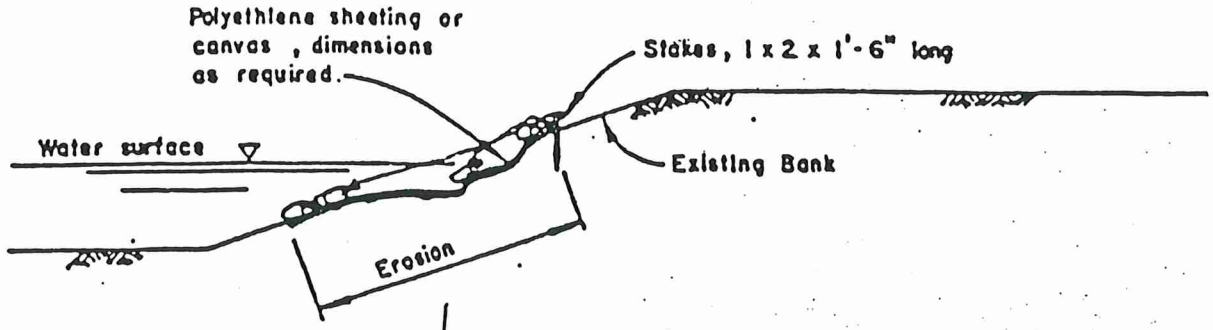
PLATE 1
CONTROL OF SAND BOILS

SACRAMENTO DISTRICT
US ARMY CORPS OF ENGINEERS

EXHIBIT G



PLAN



SECTION

NOTE:

Use polyethylene sheets, preferably 16' to 20' wide, available in standard 100' long rolls, approximately 6 mil thickness, or use canvas sheets as available. Lay length of sheeting parallel to edge of bank top. Tie upper edge to stakes and tie sacks to bottom edge. Crew will then simultaneously toss all bottom sacks over damaged slope to avoid tearing. Remaining intermediate sacks will be immediately placed as shown to hold down sheeting. Have ALL items prepared beforehand. Begin laying sheets from downstream end of erosion to enable correct lapping of sheets. Overlap edges a minimum of 2 feet.

BILL OF MATERIAL FOR 100 FEET

LUMBER

30 Sharpened stakes 1" x 2" x 18"

SANDBAGS

120 Bags

SHEETING

Polyethylene or Canvas sheeting as required

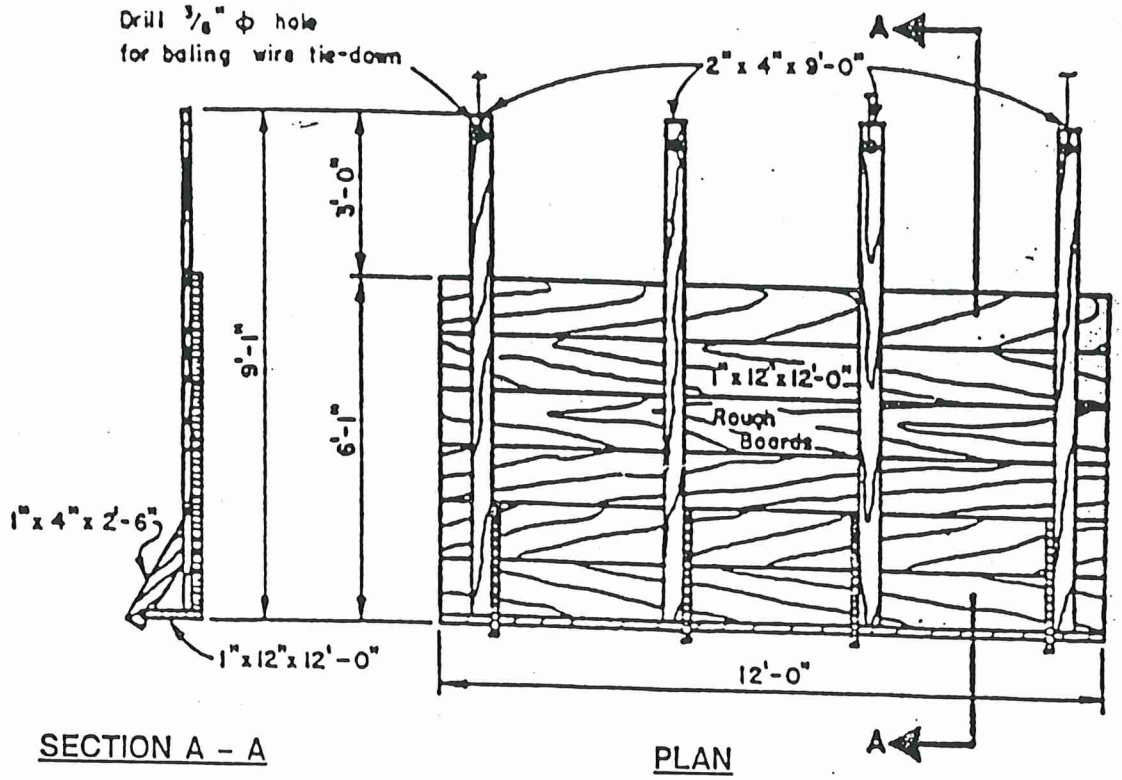
WIRE

650 ft. 16 Gauge Baling Wire

PLATE 2
WAVE WASH PROTECTION

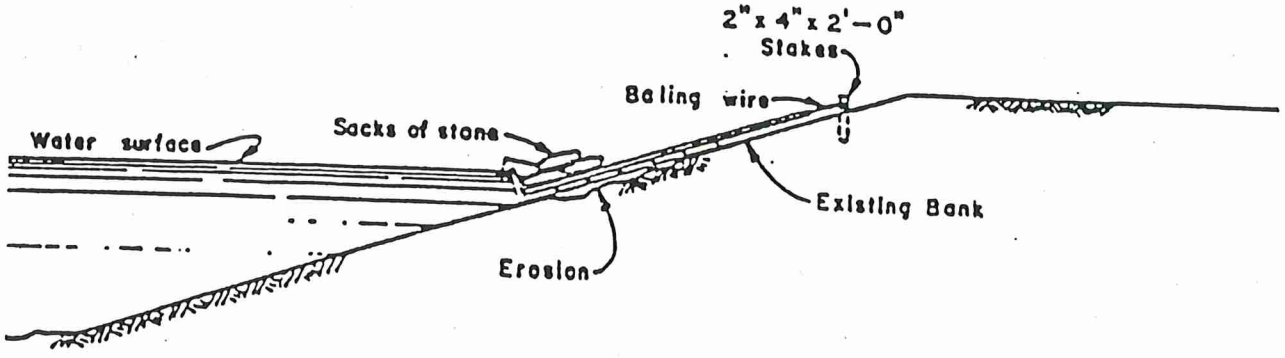
SACRAMENTO DISTRICT
US ARMY CORPS OF ENGINEERS

EXHIBIT G



SECTION A – A

PLAN



ELEVATION

BILL OF MATERIAL FOR 100 FEET

LUMBER

56 pieces 1" x 12" x 12'-0"
32 pieces 1" x 4" x 2'-6"
32 pieces 2" x 4" x 9'-0"
*32 pieces 2" x 4" x 2'-0"
*sharpened

WIRE

200 ft. Baling Wire

NAILS

4-1/2 lbs. 8d nails

PLATE 3
MOVABLE WAVE WASH PROTECTION

SACRAMENTO DISTRICT
US ARMY CORPS OF ENGINEERS

EXHIBIT G

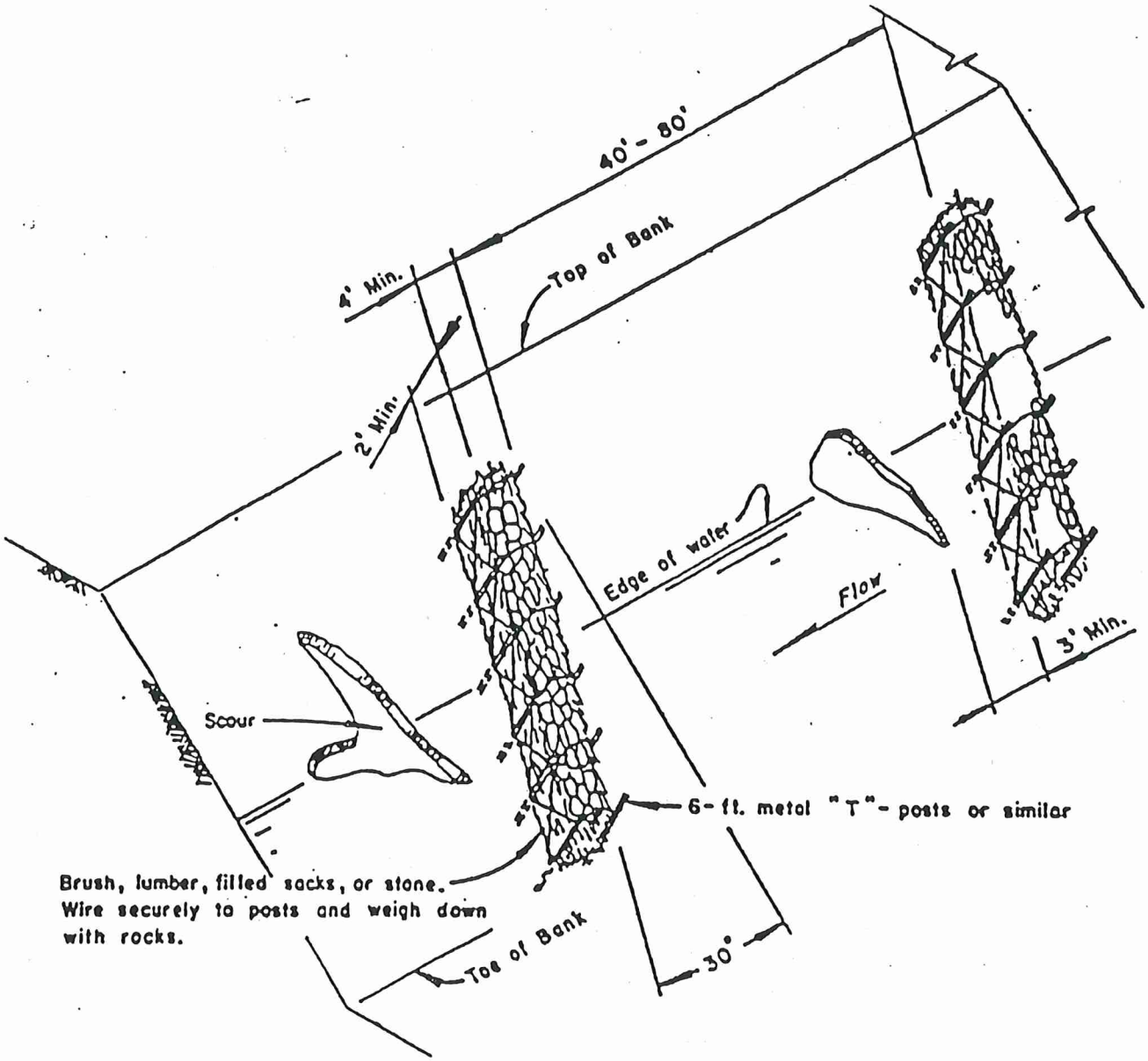


PLATE 4

DEFLECTION DIKE FOR SCOUR CONTROL

SACRAMENTO DISTRICT

US ARMY CORPS OF ENGINEERS

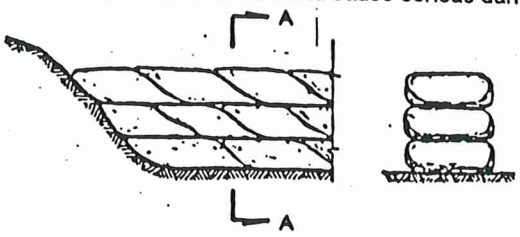
EXHIBIT G

LEVEE CONSTRUCTION

Sandbagging is used to prevent overtopping of existing levees and for retaining flood waters where no back up material is available.

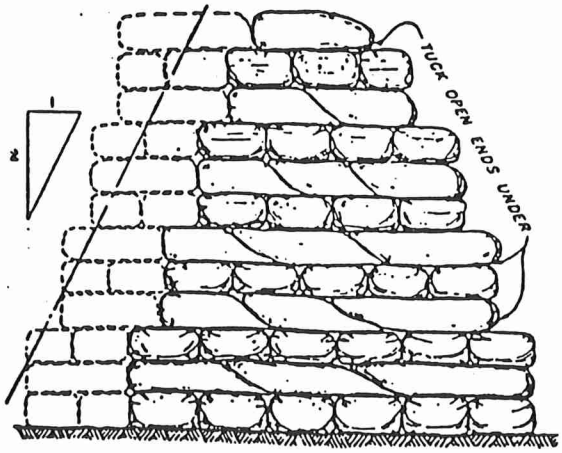
INSTRUCTIONS

1. Fill sandbags 1/2 to 1/3 full but leave enough flap to turn under. Do not tie. Leave ends open.
2. For heights of one foot or less, lay 3 single courses with sacks lengthwise as shown in sketch "A" below.
3. For heights greater than one foot, place as indicated in sketch "B" below.
4. When bags are placed, flatten out and fill voids by mashing bags with feet and vigorously tramp each course of the levee section. This is an extremely important operation for providing a levee which will be as impervious to water as possible and to insure stability of section. Loosely placed sandbags, improperly keyed together, may result in failure and cause serious damage.



ELEVATION SECTION A-A

SKETCH "A"



LEVEE SECTION

For heights in excess of the above (approx. 3'-6") hold same batter and build on the side as indicated by dashed lines above. Alternate header courses (bags placed crosswise) and stretcher courses (bags placed lengthwise).

SKETCH "B"

ESTIMATING DATA:

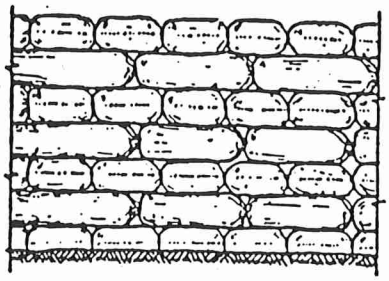
1. Average sandbag weight- approx. 50 lbs.
2. Approx. 1000 sandbags are required for 100 sq. ft. of surface (height x distance).

REVETMENTS

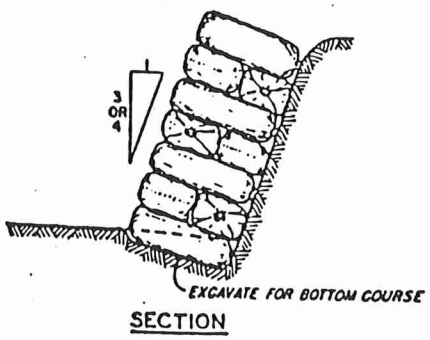
Used for emergency bank protection to prevent under cutting and control course of flood channels.

INSTRUCTIONS:

1. Fill sandbags 2/3 full and tie open ends.
2. Tuck in bottom corners of bag after filling.
3. Place bags perpendicular to slope.
4. Lay stretcher and header courses with choke and side seams in as shown below:



ELEVATION



SECTION

ESTIMATING DATA:

1. Average sandbag weight- approx. 65 lbs.
2. Approx. 320 sandbags are required for each 100 sq. ft. of surface to be reveted.

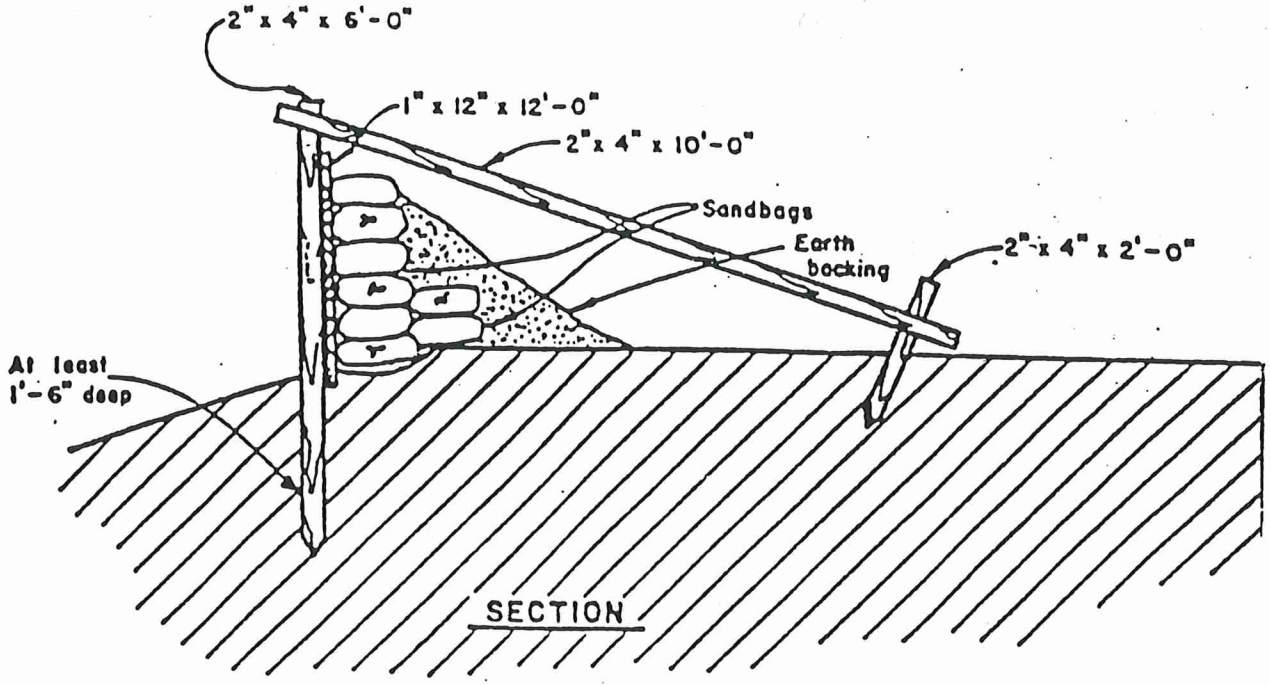
FILL MATERIAL:

The ideal material for filling sandbags is a fine sand or coarse silt. Avoid, as much as possible, the use of coarse gravel and heavy clays.

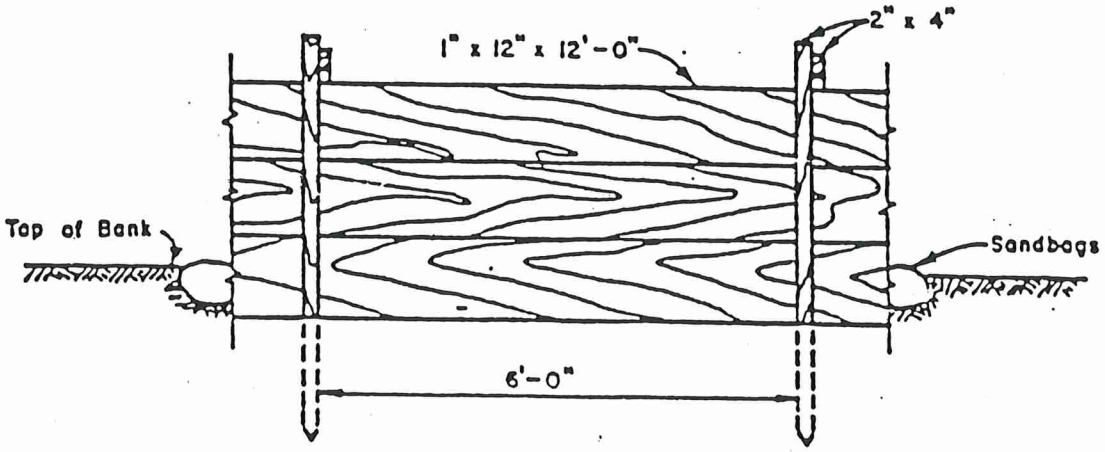
PLATE 5 (1 OF 2)
INSTRUCTIONS FOR PLACING SANDBAGS

SACRAMENTO DISTRICT
US ARMY CORPS OF ENGINEERS

EXHIBIT G



SECTION



FRONT ELEVATION

BILL OF MATERIAL FOR 100 LINEAR FEET OF BANK

LUMBER

25 pieces 1" x 12" x 12'-0"
17 pieces 2" x 4" x 10'-0"
*17 pieces 2" x 4" x 6'-0"
*17 pieces 2" x 4" x 2'-0"
* sharpened

NAILS

1 lb. 8d nails
2 lbs. 16d nails

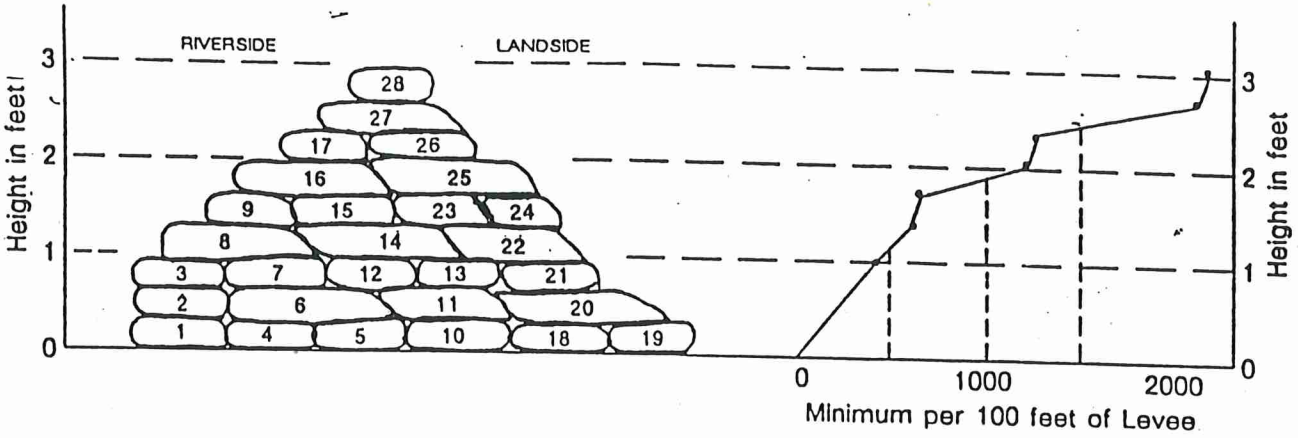
SANDBAGS

120 Bags

PLATE 6
LUMBER & SANDBAG TOPPING

SACRAMENTO DISTRICT
US ARMY CORPS OF ENGINEERS

EXHIBIT G



SANDBAG LEVEE CROSS SECTION

NUMBER OF SANDBAGS

Scale in feet

Notes:

1. Entire base to be cleared and scarified.

2. Best material for filling sandbags is a fine sand or coarse silt. Avoid, as much as possible, the use of coarse gravel and heavy clays.

3. Fill sandbags 1/2 to 2/3 full, 50 to 60 pounds, and leave enough flap to turn under. Do not tie.

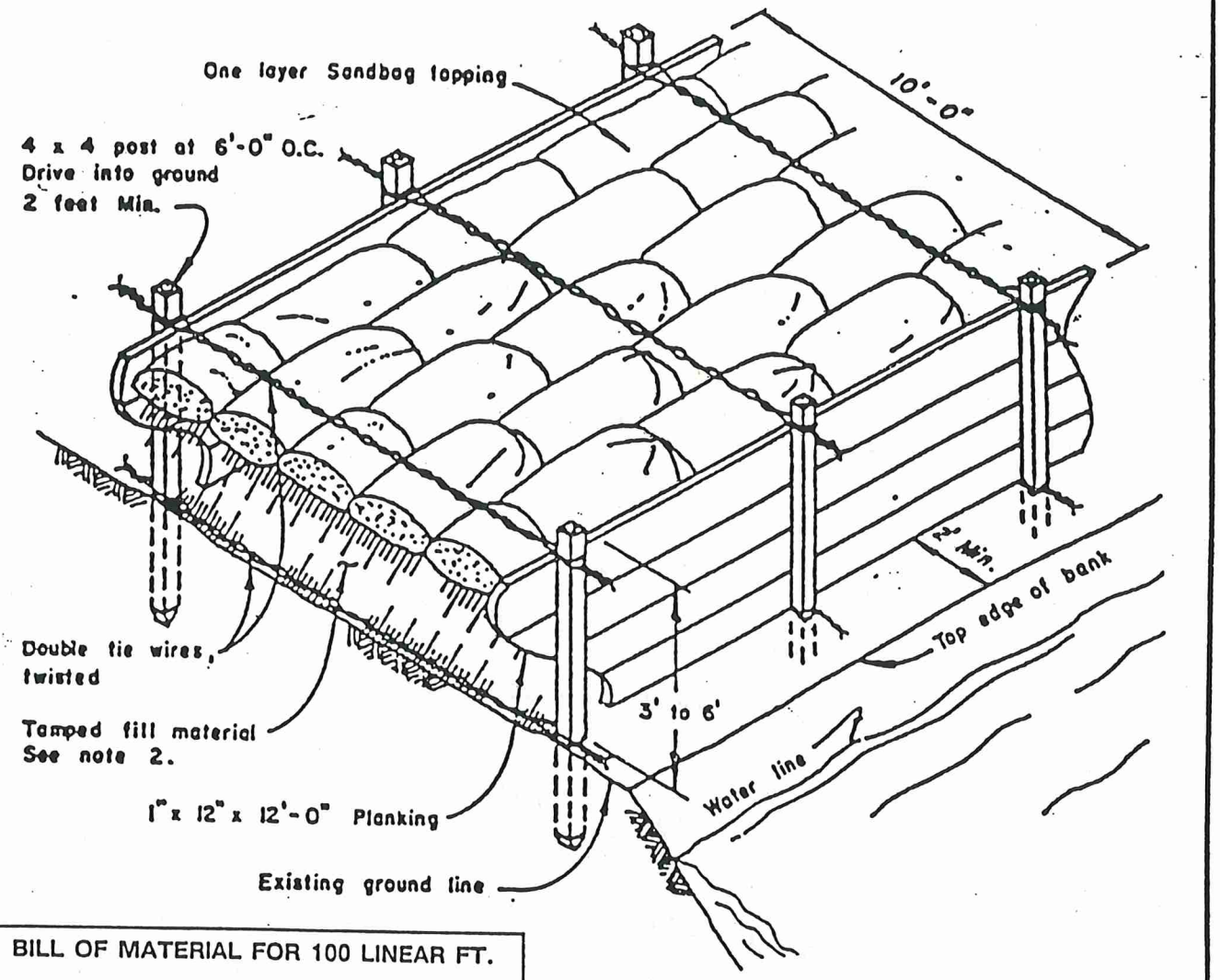
4. Numbers shown on the sandbags are for the general order of placing the sandbags to give the highest protection with the minimum number of sandbags.

5. When bags are placed, flatten out and fill voids by mashing bags with feet and vigorously tramping each course of the levee. This will make the levee section as impervious to water as possible. Alternate direction of sacks and stagger joints wherever practical.

6. The above section is based upon an average in-place sandbag section of 4" x 12" x 18".

PLATE 5 (2 OF 2)
INSTRUCTIONS FOR PLACING SANDBAGS

SACRAMENTO DISTRICT
US ARMY CORPS OF ENGINEERS



BILL OF MATERIAL FOR 100 LINEAR FT.

4 FEET HIGH

*34 Pieces lumber 4" x 4" x 7'-0"
67 pieces lumber 1" x 12" x 12'-0"
25 lbs. - 12 gauge wire
13 lbs. - 10d nails
600 sandbags
140 CY earth-fill material

5 FEET HIGH

*34 Pieces lumber 4" x 4" x 8'-0"
84 pieces lumber 1" x 12" x 12'-0"
25 lbs. - 12 gauge wire
15 lbs. - 10d nails
600 sandbags
185 CY earth-fill material

6 FEET HIGH

*34 Pieces lumber 4" x 4" x 9'-0"
100 pieces lumber 1" x 12" x 12'-0"
25 lbs. - 12 gauge wire
17 lbs. - 10d nails
600 sandbags
222 CY earth-fill material

* Sharpened

NOTES:

1. This method may be used when flood flows threaten to overtop the bank.

2. Inside walls of planking should be lined with canvas or polyethylene sheeting when fill material has a soupy consistency.

3. Moderate to heavy vegetation should be cleared to discourage water seepage.

PLATE 7

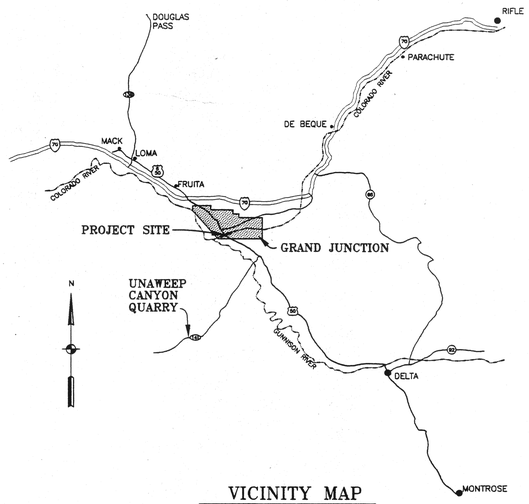
MUD BOX LEVEE TO PREVENT OVERTOPPING

SACRAMENTO DISTRICT
US ARMY CORPS OF ENGINEERS

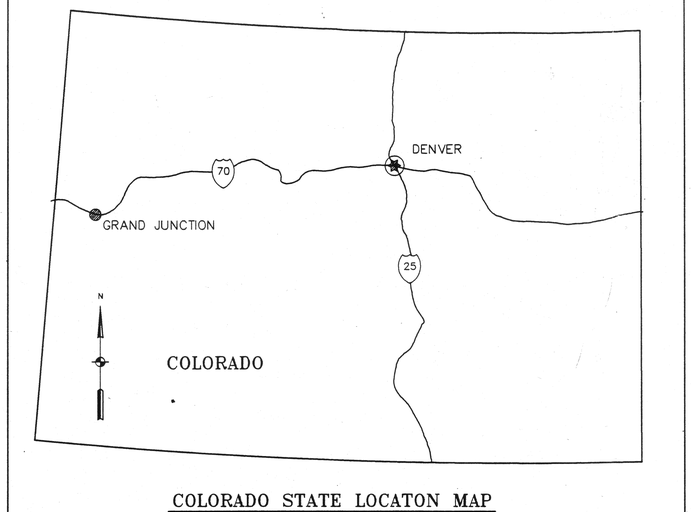
APPENDIX D

GRAND JUNCTION, COLORADO

LEVEE PROJECT

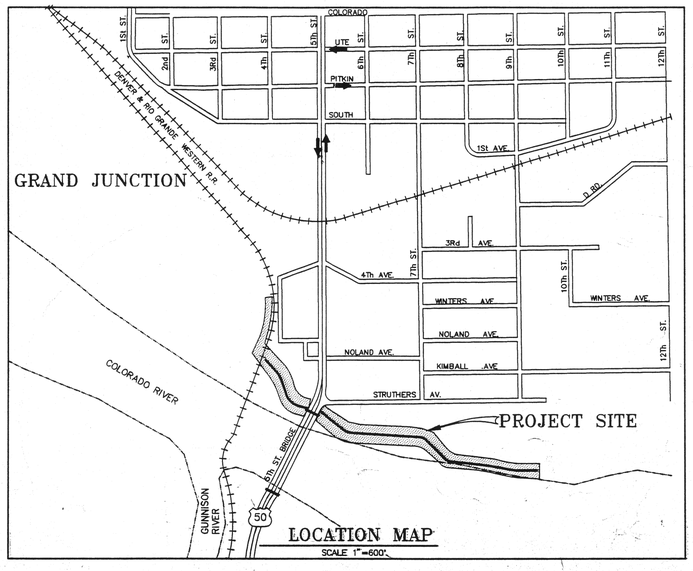


VICINITY MAP
(NO SCALE)



COLORADO STATE LOCATON MAP
(NO SCALE)

INDEX:



LOCATION MAP
SCALE 1"=600'

As-Built

REVISION	DATE	DESCRIPTION	BY	BY

APPLIED WATER ENGINEERS, INC.
150 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S. TICE
CHECKED: W. FULLERTON
COMPLETED: William T. Fullerton 3/30/94

GRAND JUNCTION COLORADO
LEVEE PROJECT
COVER SHEET

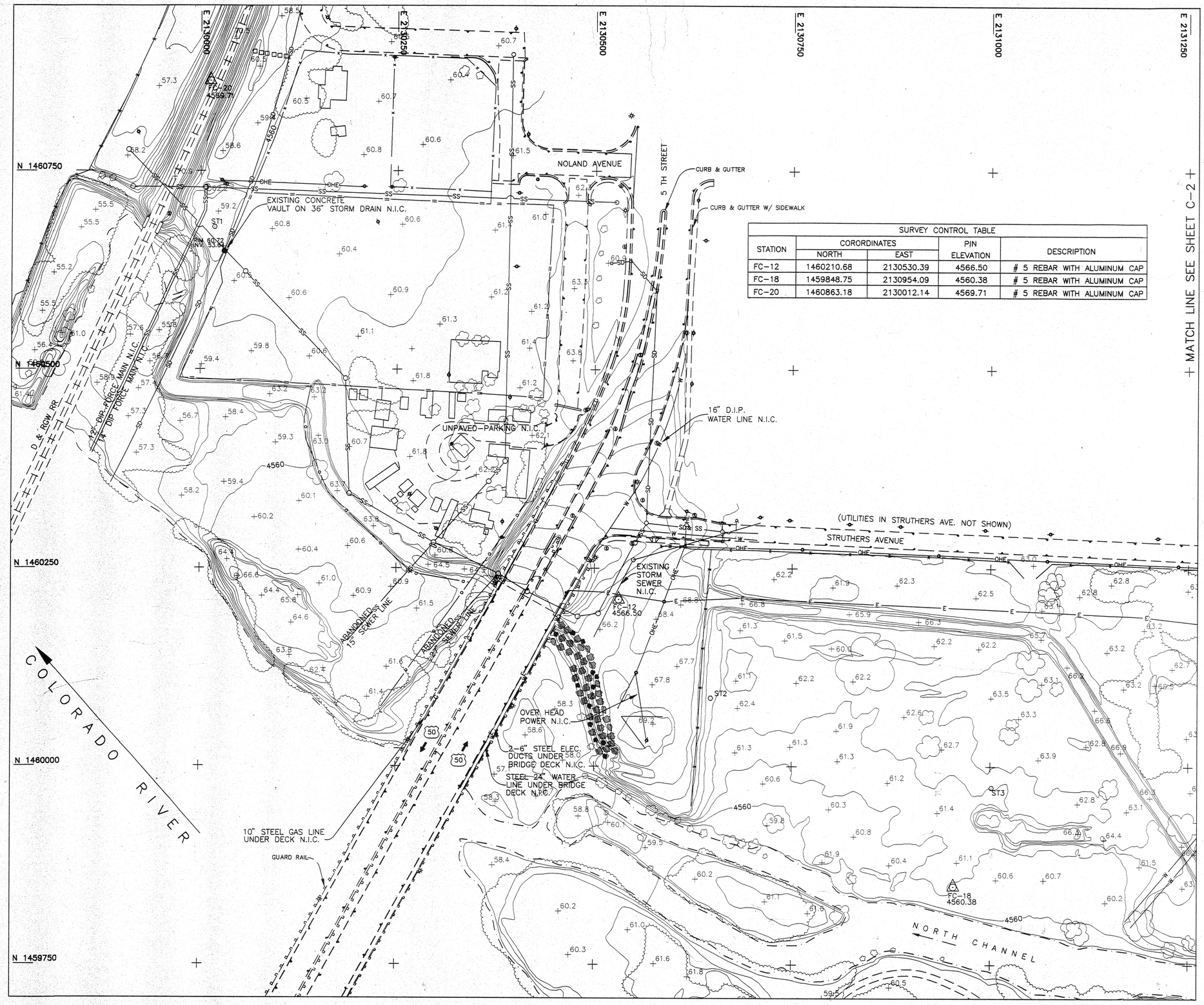
COLORADO REGISTERED WILLIAM T. FULLERTON 22353 PROFESSIONAL ENGINEER

APPROVAL RECOMMENDED: G. Raymond E. Williams, CHIEF, CIVIL DESIGN BRANCH
APPROVED: Randall M. Reber, CHIEF, ENGINEERING DIVISION
DATE: 9 AUGUST 1994

PREPARED UNDER THE DIRECTION OF
JOHN N. REESE
COL., CORPS OF ENGINEERS, U. S. A. DISTRICT ENGINEER

SCALE: NONE
SHEET: G-1 1 OF 14
FILE No.: 12-13-012
SPEC. No.: 9349

COVER.DWG 3/7/94



+ MATCH LINE SEE SHEET C-2 +

SURVEY CONTROL TABLE				
STATION	CORORDINATES		PIN ELEVATION	DESCRIPTION
	NORTH	EAST		
FC-12	1460210.68	2130530.39	4566.50	# 5 REBAR WITH ALUMINUM CAP
FC-18	1459848.75	2130954.09	4560.38	# 5 REBAR WITH ALUMINUM CAP
FC-20	1460863.18	2130012.14	4569.71	# 5 REBAR WITH ALUMINUM CAP

CIVIL LEGEND OF MATERIALS - PLAN

PROPOSED	EXISTING	TO BE REMOVED	
			BUILDING
			PAVED ROADS
			GRAVEL OR DIRT ROADS
			EDGE OF WATER
3500	3500		CONTOUR LINES (5)
			CONTOUR LINES (1)
25.2	+25.2		FINISH GRADE / SPOT ELEVATION
			SWALE OR DITCH
			RAILROAD TRACK
	SS		FORCE MAIN (SEWER)
	W	W	WATER LINE
	FH		FIRE HYDRANT
			GATE VALVE
	SS	SS	SANITARY SEWER LINE
			MANHOLE
	SD	SD	STORM DRAIN LINE
			STORM DRAIN INLET OR CATCH BASIN
			MANHOLE W/SLOTTED INLET
	G	G	GAS LINE
	T	T	TELEPHONE LINE (UNDERGROUND)
	E	E	ELECTRICAL LINE (UNDERGROUND)
	OHE	OHE	ELECTRICAL LINE (OHE=OVERHEAD ELEC.)
			POWER POLE
			LUMINAIRE
	S		SIGN
			WOOD FENCE
			CHAIN LINK FENCE
	X X X	X X X	WIRE MESH FENCE
			STORM DRAIN CULVERTS
			BOLLARDS
	FC-24 4566.08		PANEL CONTROL POINT
	ST5 4564.16		SOIL TEST HOLE
			TREE
			TREE LINE
			RIPRAP
W			RELIEF WELLS

ABBREVIATION LEGEND

N.I.C.	NOT IN CONTRACT
RCP	REINFORCED CONCRETE PIPE
D.I.P.	DUCTILE IRON PIPE
C.I.P.	CAST IRON PIPE
TYP	TYPICAL
LF	LINEAL FEET
CL	CENTER LINE

NUMBER OF SHEET ON WHICH SECTION OR DETAIL IS TAKEN MAY BE MORE THAN ONE SHEET.

8 / C 4 / C 1.1

SECTION OR DETAIL IDENTIFICATION NUMBER

NUMBER OF SHEET ON WHICH SECTION OR DETAIL IS DRAWN

NOTES:
1. AERIAL, SURVEY, & MAPPING PREPARED JULY 1993 BY KLH – INTERMOUNTAIN TECHNICAL SERVICE, GRAND JUNCTION, COLORADO
2. ALL ELEVATIONS BASED ON N.G.V.D. 1929
3. GRID COORDINATES ARE BASED ON COLORADO STATE COORDINATE SYSTEM, ZONE C, COMBINED FACTOR = .99971593
4. PANEL CONTROL POINTS SHALL BE USED FOR CONSTUCTION STAKING
5. SANITARY SEWER LINE SURVEYED AUGUST 1993 BY KLH–ITS, ALL OTHER UTILITIES BASED ON PREVIOUS MAPPING.

N

GRAPHIC SCALES

1" = 50' 0 10' 25' 50' 100' 150' 200'

REVISION	DATE	DESCRIPTION	BY	BY

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: KLH – INTERMOUNTAIN TECHNICAL SERVICES INC.
DRAWN: KLH – INTERMOUNTAIN TECHNICAL SERVICES INC.
CHECKED: APPLIED WATER ENGINEERS INC.

GRAND JUNCTION COLORADO

LEVEE PROJECT

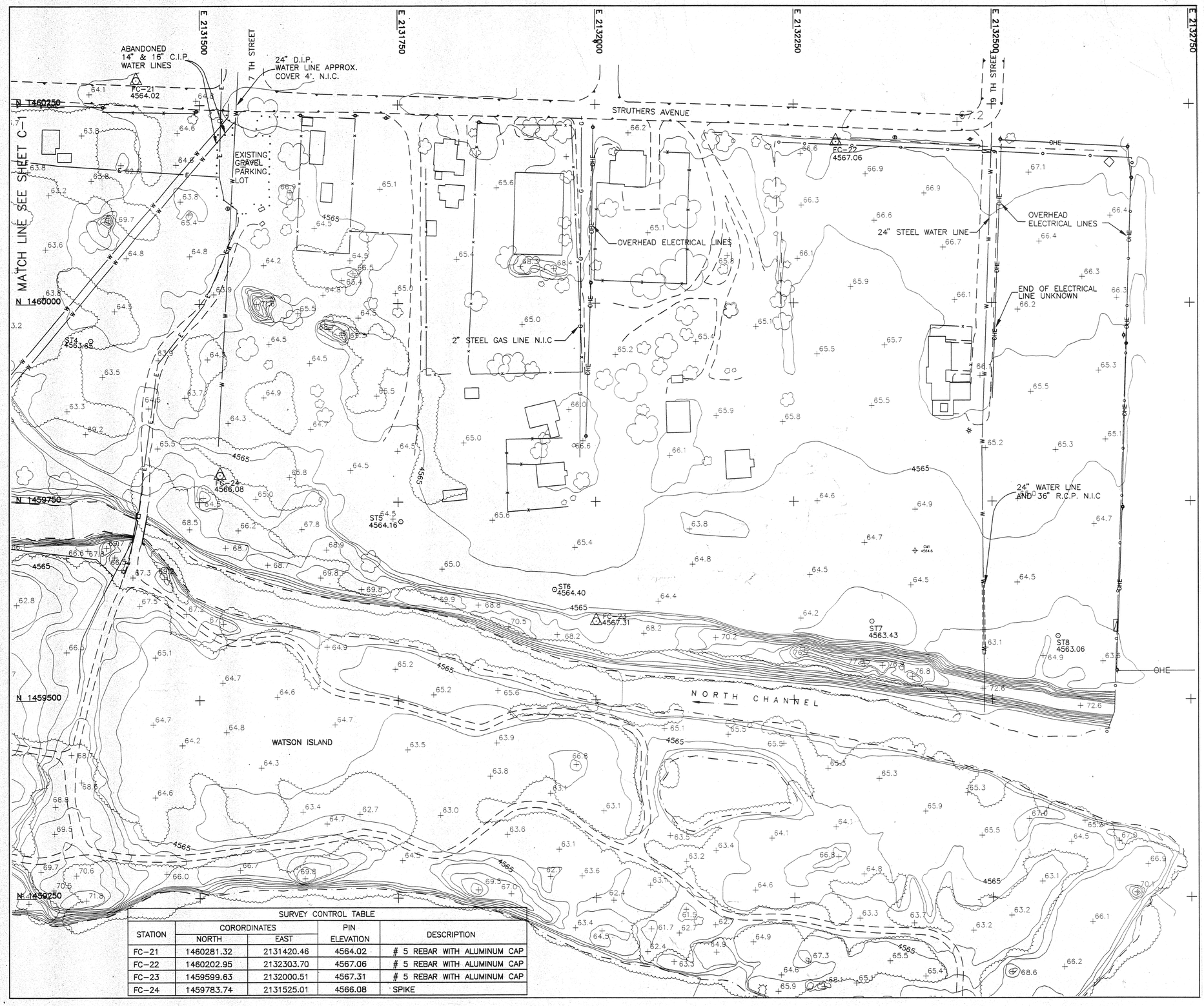
EXISTING TOPOGRAPHY

SUBMITTED: Darnell W. Hoxter
CHIEF, DESIGN & STUDIES SECTION

DATE APPROVED: 2 Aug 94

SCALE: AS SHOWN SPEC. No.: 9349
SHEET: C-1 2 OF 14
FILE No.: 12-13-012

GLEVEE.DWG 3/7/94



SURVEY CONTROL TABLE

STATION	CORORDINATES		PIN ELEVATION	DESCRIPTION
	NORTH	EAST		
FC-21	1460281.32	2131420.46	4564.02	# 5 REBAR WITH ALUMINUM CAP
FC-22	1460202.95	2132303.70	4567.06	# 5 REBAR WITH ALUMINUM CAP
FC-23	1459599.63	2132000.51	4567.31	# 5 REBAR WITH ALUMINUM CAP
FC-24	1459783.74	2131525.01	4566.08	SPIKE

CIVIL LEGEND OF MATERIALS – PLAN

PROPOSED	EXISTING	TO BE REMOVED	
			BUILDING
			PAVED ROADS
			GRAVEL OR DIRT ROADS
			EDGE OF WATER
3500	3500		CONTOUR LINES (5)
			CONTOUR LINES (1)
25.2	+25.2		FINISH GRADE SPOT ELEVATION
			SWALE OR DITCH
			RAILROAD TRACK
	SS		FORCE MAIN (SEWER)
	W	W	WATER LINE
	FH		FIRE HYDRANT
			GATE VALVE
	SS	SS	SANITARY SEWER LINE
			MANHOLE
	SD	SD	STORM DRAIN LINE
			STORM DRAIN INLET OR CATCH BASIN
			MANHOLE W/SLOTTED INLET
	G	G	GAS LINE
	T	T	TELEPHONE LINE (UNDERGROUND)
	E	E	ELECTRICAL LINE (UNDERGROUND)
	OHE	OHE	ELECTRICAL LINE (OHE=OVERHEAD ELEC.)
			POWER POLE
			LUMINAIRE
	S		SIGN
	=	=	WOOD FENCE
	o	o	CHAIN LINK FENCE
	X X X	X X X	WIRE MESH FENCE
			STORM DRAIN CULVERTS
			BOLLARDS
	FC-24 4566.08		PANEL CONTROL POINT
	ST5 4564.16		SOIL TEST HOLE
			TREE
			TREE LINE
			RIPRAP
W			RELIEF WELLS

ABBREVIATION LEGEND

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D.I.P.	DUCTILE IRON PIPE
C.I.P.	CAST IRON PIPE
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LF	LINEAL FEET
CL	CENTER LINE

NUMBER OF SHEET ON WHICH SECTION OR DETAIL IS TAKEN. MAY BE MORE THAN ONE SHEET.

8 / C 4 / 11

SECTION OR DETAIL IDENTIFICATION NUMBER

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N

GRAPHIC SCALES

1" = 50' 0 10' 25' 50' 100' 150' 200'

REVISION	DATE	DESCRIPTION	BY	BY

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: KLH – INTERMOUNTAIN TECHNICAL SERVICES INC.
DRAWN: KLH – INTERMOUNTAIN TECHNICAL SERVICES INC.
CHECKED: APPLIED WATER ENGINEERS INC.

GRAND JUNCTION COLORADO

LEVEE PROJECT

EXISTING TOPOGRAPHY

SUBMITTED: Darrell W. Horton
CHIEF, DESIGN & STUDIES SECTION

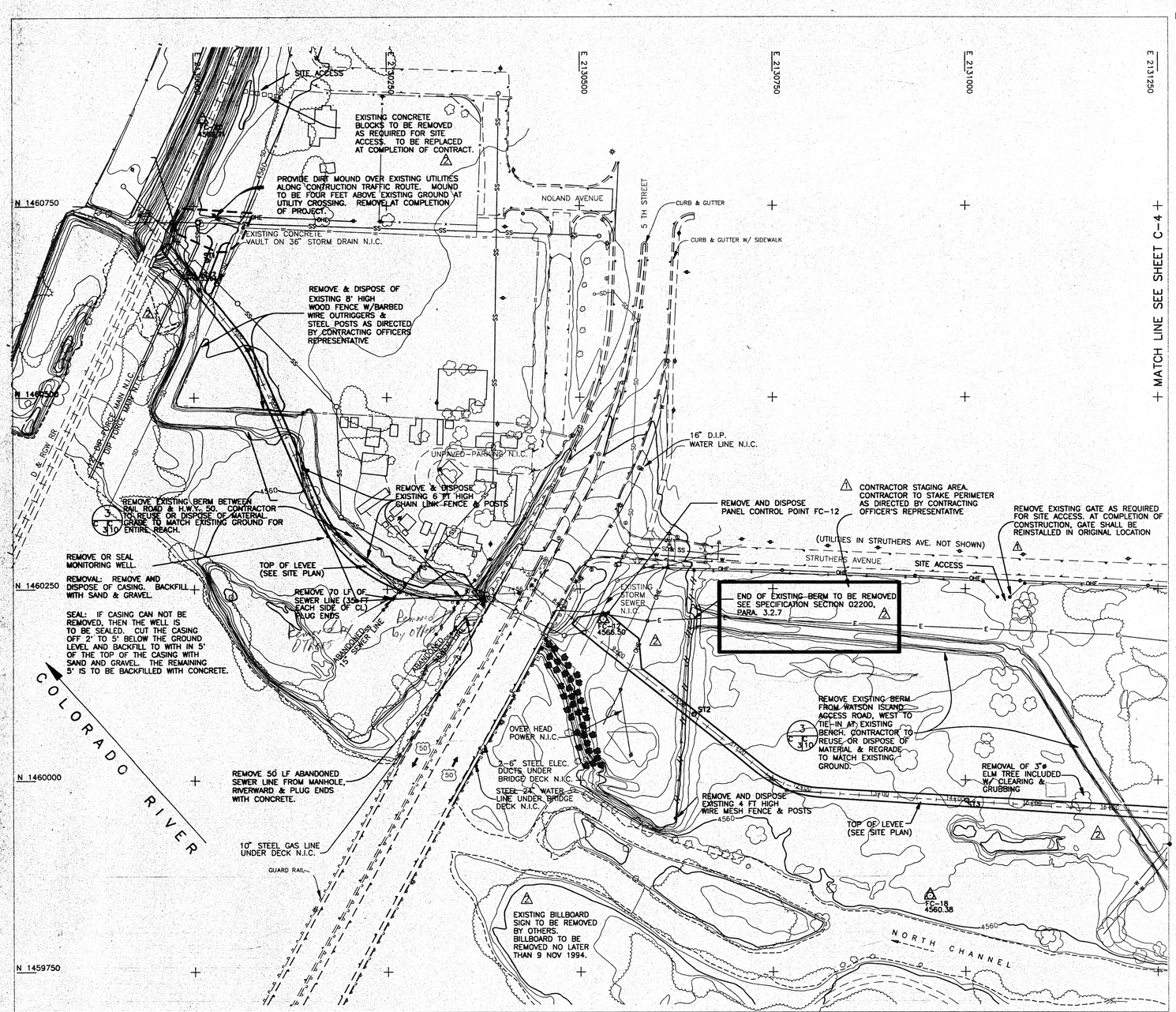
DATE APPROVED: 2 Aug 94

SCALE: AS SHOWN SPEC. No.: 9349
SHEET: C-2 (3 OF 14) FILE No.: 12-13-012

GLEVEE.DWG 3/7/94

ENVIRONMENTAL ENHANCEMENT THRU ENGINEERING

FUNCTIONAL ANALYSIS – VE PAYS



CIVIL LEGEND OF MATERIALS - PLAN

PROPOSED	EXISTING	TO BE REMOVED	
			BUILDING
			PAVED ROADS
			GRAVEL OR DIRT ROADS
			EDGE OF WATER
3500	3500		CONTOUR LINES (5)
			CONTOUR LINES (1)
25.2	+25.2		FINISH GRADE SPOT ELEVATION
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	W	W	WATER LINE
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			WOOD FENCE
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2. CONTRACTOR TO CALL FOR UTILITY LOCATES PRIOR TO ANY DEMOLITION, CONSTRUCTION, OR MOBILIZATION ONTO SITE.
3. ANY DAMAGE TO ITEMS NOT IN CONTRACT SHALL BE REPAIRED OR REPLACED AT NO ADDITIONAL COST TO THE GOVERNMENT.
4. CONTRACTOR CONSTRUCTION AREA RIGHT OF WAY LIMITS: LEVEE EMBANKMENT FOOTPRINT AND ACCESS PLUS 10 FEET EITHER SIDE; RAILROAD EMBANKMENT SECTION PLUS 10 FEET; DETENTION BASIN FINISH GRADE LINE PLUS 10 FEET, TREE PLANTING SITES, FOOTPRINT OF EXISTING BERM REMOVAL PLUS 10 FEET EITHER SIDE, AND CONSTRUCTION STAGING AREA.
5. CONTRACTOR TO CLEAR AND GRUB ENTIRE LEVEE ALIGNMENT. CLEARING AND GRUBBING LIMITS TO EXTEND FROM CENTERLINE OF THE LEVEE TO 10 FEET FROM THE TOE.

GRAPHIC SCALES

1" = 50' 0 10' 25' 50' 100' 150' 200'

REVISION	DATE	DESCRIPTION	BY	BY
2	9/13/94	CHANGE CLEARING & GRUBBING LIMITS, VARIOUS NOTES	RC	[illegible]
1	8/17/94	MISCELLANEOUS REVISIONS	RC	[illegible]

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD., SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S.TICE
CHECKED: W. FULLERTON
SUBMITTED: [signature] CHIEF, DESIGN & STUDIES SECTION
DATE APPROVED: 2 Aug 94

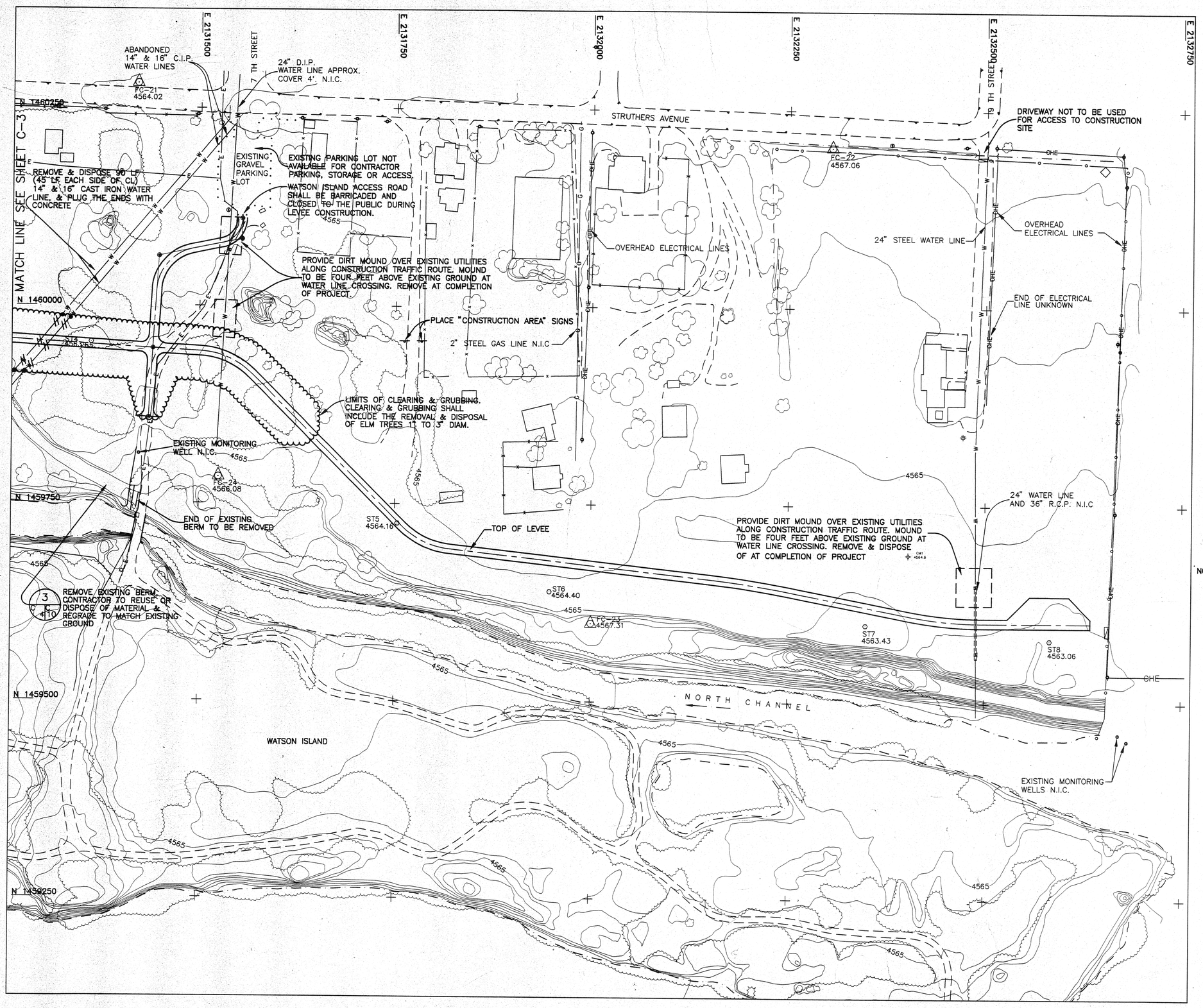
GRAND JUNCTION COLORADO
LEVEE PROJECT

DEMOLITION, STAGING, & ACCESS PLAN

SCALE: AS SHOWN SPEC No. 9349
SHEET: C-3 4 OF 14 FILE No. 12-13-012

jmc3.dwg 9/19/94

SAFETY PAYS



CIVIL LEGEND OF MATERIALS - PLAN

PROPOSED	EXISTING	TO BE REMOVED	
			BUILDING
			PAVED ROADS
			GRAVEL OR DIRT ROADS
			EDGE OF WATER
3500	3500		CONTOUR LINES (5)
			CONTOUR LINES (1)
25.2			FINISH GRADE
	+25.2		SPOT ELEVATION
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8 C-C 4/11

SECTION OR DETAIL IDENTIFICATION NUMBER

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N

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1" = 50' 0 10' 25' 50' 100' 150' 200'

REVISION	DATE	DESCRIPTION	BY	BY

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7546
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S.TICE
CHECKED: W. FULLERTON
SUBMITTED: Darrell W Horton
CHIEF, DESIGN & STUDIES SECTION
DATE APPROVED: 2 Aug 94

GRAND JUNCTION COLORADO

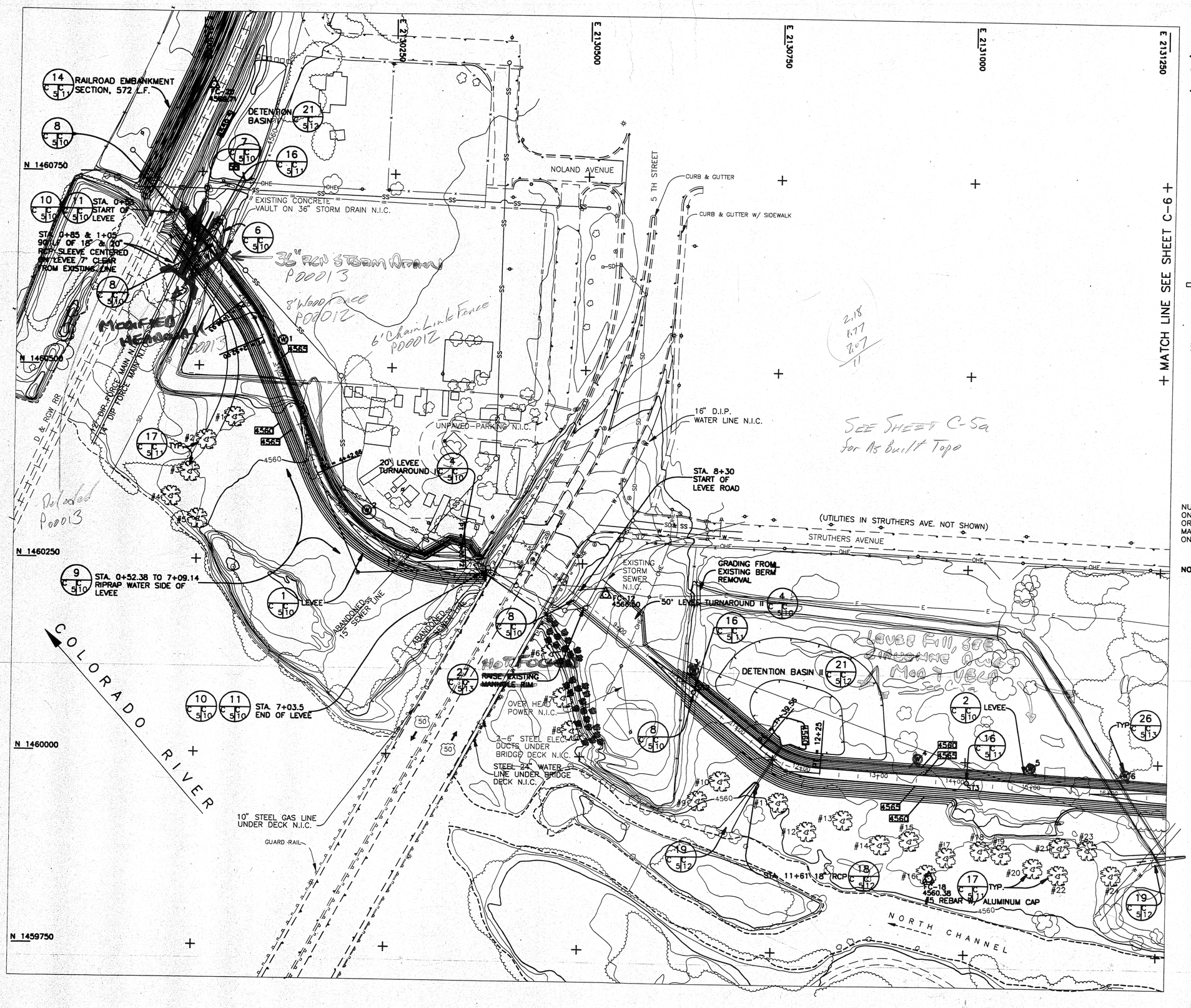
LEVEE PROJECT

DEMOLITION, STAGING, & ACCESS PLAN

SCALE: AS SHOWN
SHEET: C-4
5 OF 14
SPEC. No.: 9349
FILE No.: 12-13-012

GJLEVEE.DWG 3/7/94

FUNCTIONAL ANALYSIS – VE PAYS



CIVIL LEGEND OF MATERIALS - PLAN

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3. ANY DAMAGE TO ITEMS NOT IN CONTRACT SHALL BE REPAIRED OR REPLACED AT NO ADDITIONAL COST TO THE GOVERNMENT.
4. RELIEF WELL LOCATIONS ARE APPROXIMATE ONLY. FINAL LOCATION SHALL BE PER THE CONTRACTING, OFFICER RECOMMENDATIONS.

N

GRAPHIC SCALES

1" = 50' 0 10' 25' 50' 100' 150' 200'

REVISION	DATE	DESCRIPTION	BY	BY

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S. TICE
CHECKED: W. FULLERTON

GRAND JUNCTION COLORADO

LEVEE PROJECT

SITE PLAN

SUBMITTED: Darrell W. Horton
CHIEF, DESIGN & STUDIES SECTION

DATE APPROVED: 2 Aug 94

SCALE: AS SHOWN | SPEC. No.: 9349
SHEET: C-5 | FILE No.: 12-13-012
6 OF 14

jlnc5.dwg concpt 7/27/94

ENVIRONMENTAL ENHANCEMENT THRU ENGINEERING

SAFETY PAYS

GRAND JUNCTION LEVEE PROJECT

SEEPAGE BERM ALTERNATIVE

STRUTHERS AVE.

SOUTH 7TH STREET

HIGHWAY 50

DETENTION BASIN A

INV. 4559.50

DETENTION BASIN B

INV. 4561.60

DETENTION BASIN C

INV. 4562.80

INV. 45562.2

INV. 4558.90

DRAINAGE PIPE A

DRAINAGE PIPE B

INV. 4561.00

DRAINAGE PIPE C

MATCH LINE

PROPOSED GRADES CONFORM TO PROPOSED BOTANICAL GARDEN GRADING CONFIGURATION ON EXISTING CITY OF GRAND JUNCTION PARCEL

4560

4565

4566

4570

LEGEND

- DIKE GRADES (APPLIED WATER ENGINEERS, 8/94)
- PROPOSED GRADES
- 18" RCP

WATSON ISLAND RAMPS

Spec 9349
FILE 12-13-012
Sheet G5a

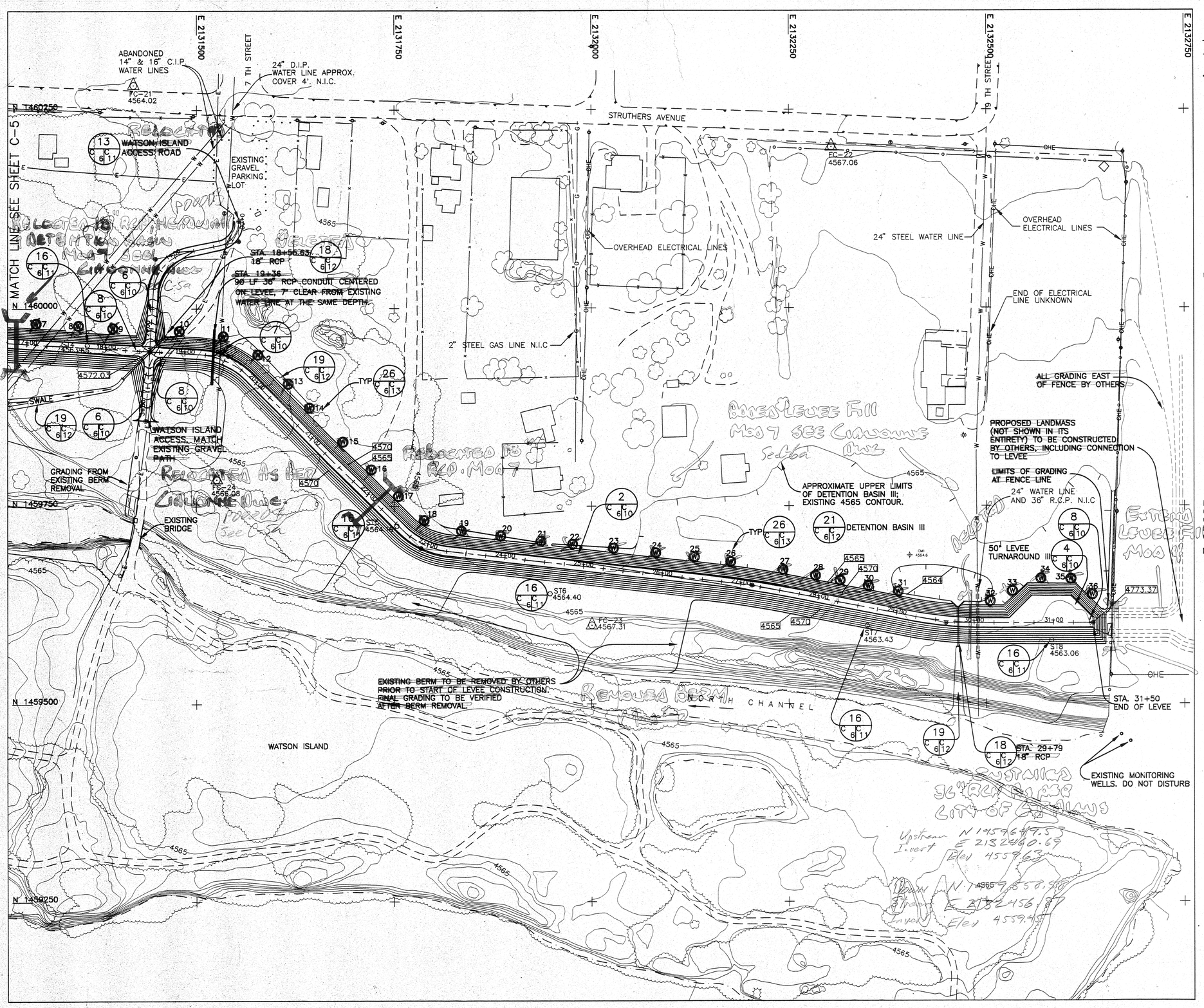
NORTH 0 25 50 100

9509-4-4-1

DRAWN C.R.
CHECKED T.C.
JOB NO. 9509
DATE 4-4-95
REVISIONS:

SHEET NO. 1 OF 2

CIAVONNE & ASSOCIATES, INC.
SITE PLANNING & LANDSCAPE ARCHITECTURE
844 GRAND AVE., #1
GRAND JUNCTION, CO.
303-241-0745
FAX 303-241-0765
81501



CIVIL LEGEND OF MATERIALS - PLAN

PROPOSED	EXISTING	TO BE REMOVED	
			BUILDING
			PAVED ROADS
			GRAVEL OR DIRT ROADS
			EDGE OF WATER
3500	3500		CONTOUR LINES (5)
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	SD	SD	STORM DRAIN LINE
			STORM DRAIN INLET OR CATCH BASIN
			MANHOLE W/SLOTTED INLET
	G	G	GAS LINE
	T	T	TELEPHONE LINE (UNDERGROUND)
	E	E	ELECTRICAL LINE (UNDERGROUND)
	OHE	OHE	ELECTRICAL LINE (OHE=OVERHEAD ELEC.)
			POWER POLE
			LUMINAIRE
			SIGN
	=	=	WOOD FENCE
	o	o	CHAIN LINK FENCE
	X X X	X	WIRE MESH FENCE
			STORM DRAIN CULVERTS
			BOLLARDS
	FC-24 4566.08		PANEL CONTROL POINT
	ST5 4564.16		SOIL TEST HOLE
			TREE
			TREE LINE
			RIPRAP
W			RELIEF WELLS

ABBREVIATION LEGEND

N.I.C.	NOT IN CONTRACT
RCP	REINFORCED CONCRETE PIPE
D.I.P.	DUCTILE IRON PIPE
C.I.P.	CAST IRON PIPE
TYP	TYPICAL
LF	LINEAL FEET
CL	CENTER LINE

8 / C 6/10 — SECTION OR DETAIL IDENTIFICATION NUMBER; NUMBER OF SHEET ON WHICH SECTION OR DETAIL IS TAKEN MAY BE MORE THAN ONE SHEET. NUMBER OF SHEET ON WHICH SECTION OR DETAIL IS DRAWN

NOTES:
1. ALL WASTE MATERIALS SHALL BE DISPOSED OF BY THE CONTRACTOR. DISPOSAL SHALL BE IN ACCORDANCE WITH CITY OF GRAND JUNCTION ORDINANCES.
2. CONTRACTOR TO CALL FOR UTILITY LOCATES PRIOR TO ANY DEMOLITION, CONSTRUCTION, OR MOBILIZATION ONTO SITE.
3. ANY DAMAGE TO ITEMS NOT IN CONTRACT SHALL BE REPAIRED OR REPLACED AT NO ADDITIONAL COST TO THE GOVERNMENT.
4. RELIEF WELL LOCATIONS ARE APPROXIMATE ONLY. FINAL LOCATION SHALL BE PER THE CONTRACTING, OFFICER RECOMMENDATIONS.

GRAPHIC SCALES

1" = 50' — 0 10' 25' 50' 100' 150' 200'

REVISION	DATE	DESCRIPTION	BY	BY

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

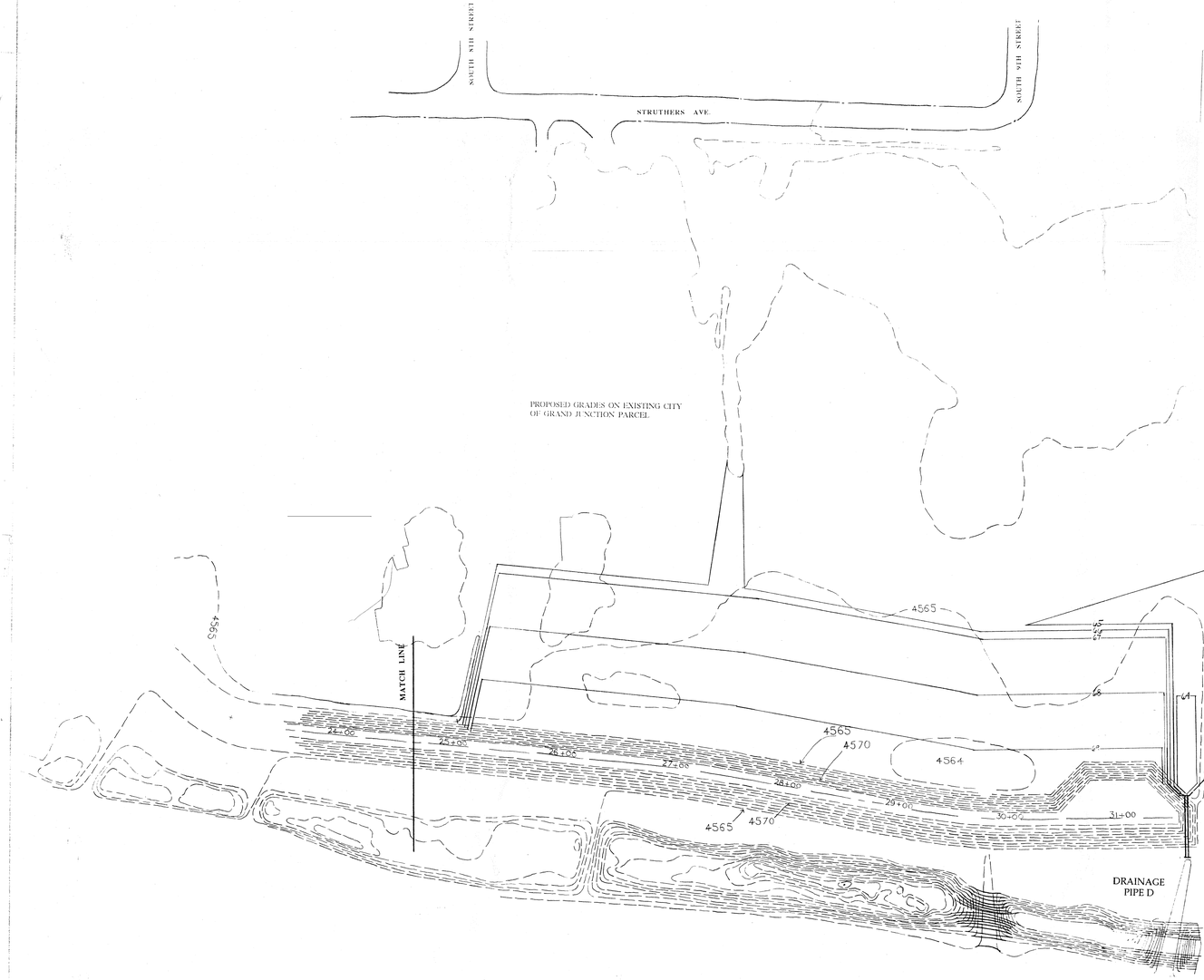
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

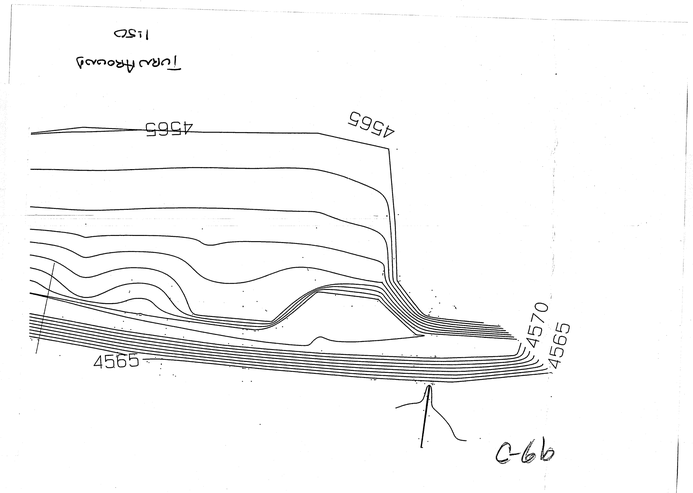
DESIGNED: P. McCARTHY
DRAWN: S.TICE
CHECKED: W. FULLERTON

GRAND JUNCTION COLORADO
LEVEE PROJECT
SITE PLAN

SUBMITTED: Darrell W. Horton, CHIEF, DESIGN & STUDIES SECTION
DATE APPROVED: 2 Aug 94
SCALE: AS SHOWN
SPEC. No.: 9349
SHEET: C-6, 7 OF 14
FILE No.: 12-13-012

GJLEVEE.DWG 3/7/94





GRAND JUNCTION LEVEE PROJECT
SEEPAGE BERM ALTERNATIVE

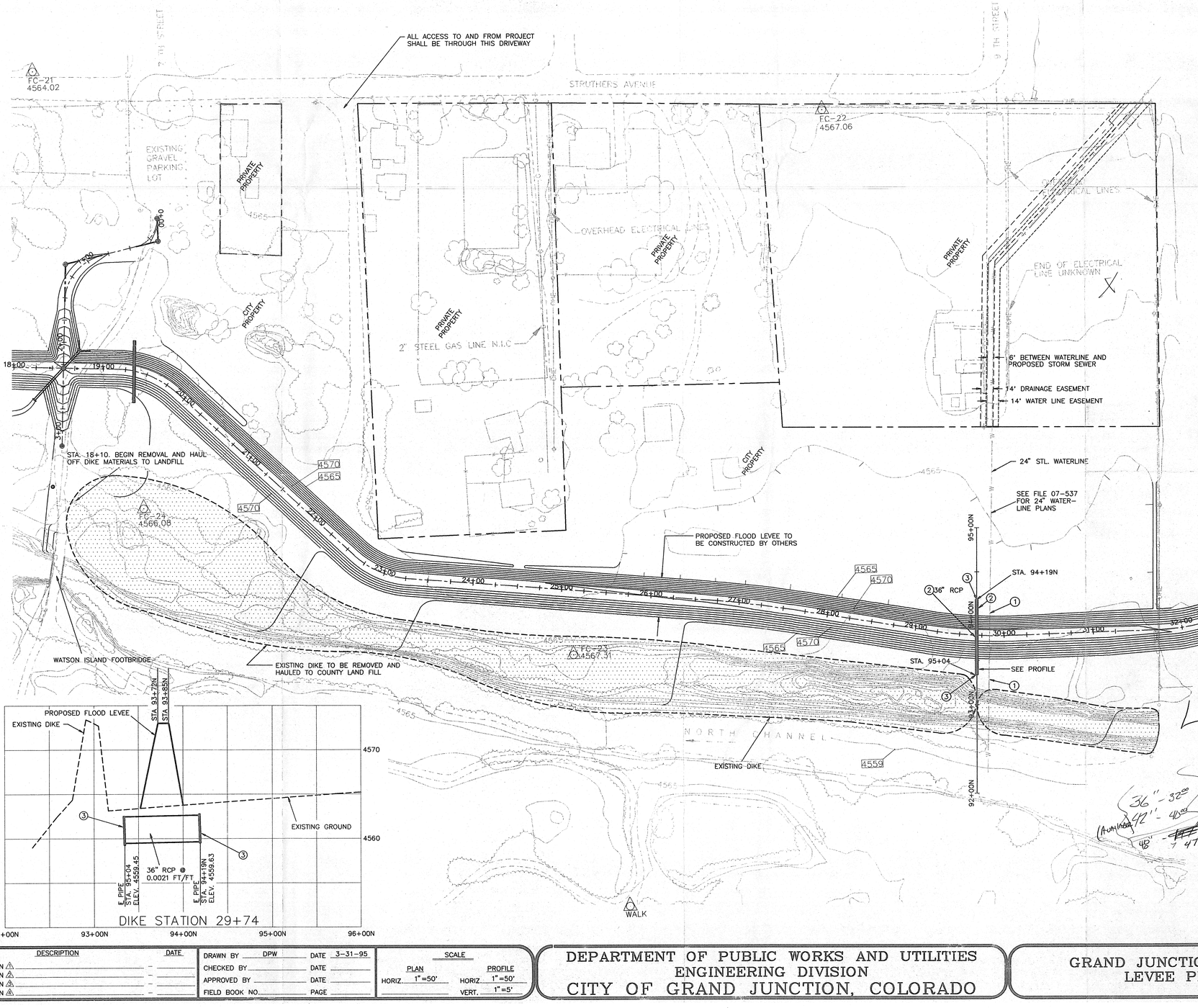
DRAWN
CHECKED
JOB NO.
DATE
REVISIONS:

SHEET NO.

Spec 9349
File 12-13-012
Sheet C-6a

CIAVONNE & ASSOCIATES, INC.
SITE PLANNING & LANDSCAPE ARCHITECTURE
844 GRAND AVE., #1
GRAND JUNCTION, CO.
303-241-0745
FAX 303-241-0765
81501

PROJECT NO. 89104-21688



CONSTRUCTION NOTES

1. CONTRACTOR TO POTHOLE TO TOP OF PIPE AND CONTACT CITY OF GRAND JUNCTION SURVEYOR (GORDON GRAM, 224-1458) TO VERIFY ALIGNMENT AND DEPTH OF 24" WATER MAIN PRIOR TO CONSTRUCTION. POTHOLES ARE TO BE AT 100' AND 175' NORTHERLY OF RIVER CHANNEL ALONG PIPE ALIGNMENT.
2. FURNISH AND INSTALL 85 L.F. OF 36" REINFORCED CONCRETE PIPE CLASS III. BACKFILL PIPE WITH CLAY SOIL APPROVED BY THE CITY ENGINEER. CAP AND SEAL NORTHERLY END OF PIPE WITH STEEL PLATE.
3. CAP AND SEAL END OF PIPE WITH STEEL PLATE.

36" - 32°
42" - 40°
48" - 47½°

C-6C

3/31/95

DESCRIPTION	DATE
REVISION 1	
REVISION 2	
REVISION 3	
REVISION 4	

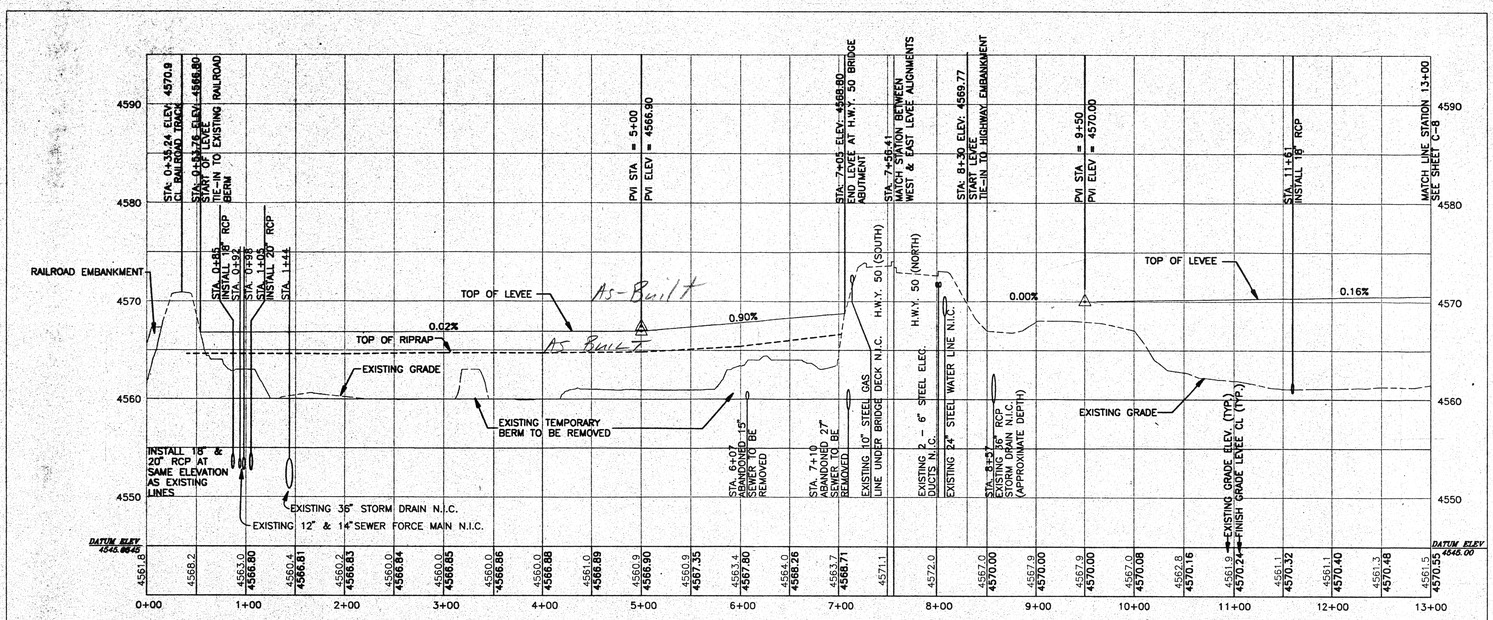
DRAWN BY DPW DATE 3-31-95
CHECKED BY DATE
APPROVED BY DATE
FIELD BOOK NO. PAGE

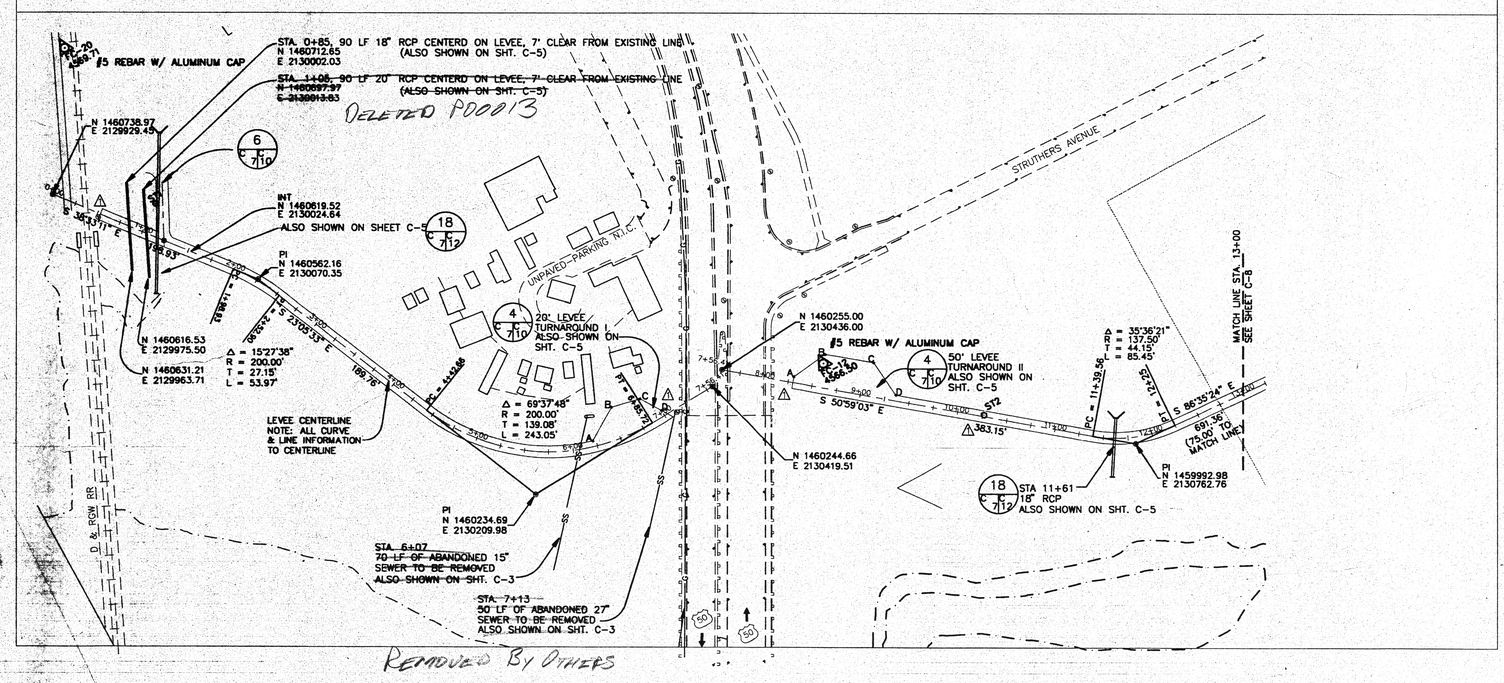
SCALE
PLAN HORIZ. 1"=50'
PROFILE HORIZ. 1"=50' VERT. 1"=5'

DEPARTMENT OF PUBLIC WORKS AND UTILITIES
ENGINEERING DIVISION
CITY OF GRAND JUNCTION, COLORADO

GRAND JUNCTION COLORADO
LEVEE PROJECT

SHEET NO. 1 OF 1
FILE NO. 89104-2.DWG





CIVIL LEGEND OF MATERIALS - PLAN

PROPOSED	EXISTING	TO BE REMOVED	
			BUILDING
			PAVED ROADS
			GRAVEL OR DIRT ROADS
			EDGE OF WATER
3500	3500		CONTOUR LINES (5)
			CONTOUR LINES (1)
25.2			FINISH GRADE
	+25.2		SPOT ELEVATION
			SWALE OR DITCH
			RAILROAD TRACK
	SS		FORCE MAIN (SEWER)
	W		WATER LINE
	FH		FIRE HYDRANT
	GV		GATE VALVE
	SS		SANITARY SEWER LINE
			MANHOLE
	SD		STORM DRAIN LINE
			STORM DRAIN INLET OR CATCH BASIN
			MANHOLE W/SLOTTED INLET
	G		GAS LINE
	T		TELEPHONE LINE (UNDERGROUND)
	E		ELECTRICAL LINE (UNDERGROUND)
	OHE		ELECTRICAL LINE (OHE=OVERHEAD ELEC.)
			POWER POLE
			LUMINAIRE
			SIGN
			WOOD FENCE
			CHAIN LINK FENCE
			WIRE MESH FENCE
			STORM DRAIN CULVERTS
			BOLLARD (LOCATION ON C-5 & C-6)
	PC-24 4566.08		PANEL CONTROL POINT
	ST5 4564.16		SOIL TEST HOLE
			TREE
			TREE LINE

ABBREVIATION LEGEND

N.I.C.	NOT IN CONTRACT
RCP	REINFORCED CONCRETE PIPE
D.I.P.	DUCTILE IRON PIPE
C.I.P.	CAST IRON PIPE
TYP	TYPICAL
LF	LINEAL FEET
CL	CENTER LINE

NUMBER OF SHEET ON WHICH SECTION OR DETAIL IS TAKEN MAY BE MORE THAN ONE SHEET.

8 / 5 10 — 8: SECTION OR DETAIL IDENTIFICATION NUMBER; 5/10: NUMBER OF SHEET ON WHICH SECTION OR DETAIL IS DRAWN

1. SEE SHEETS C-5, & C-6 FOR HORIZONTAL LOCATIONS OF EXISTING STRUCTURES ALONG LEVEE PROFILE.

N

GRAPHIC SCALES

1" = 100' 0 10' 25' 50' 100' 150' 200'

REVISION	DATE	DESCRIPTION	BY
A	8/17/94	BOLLARD LOCATIONS DELETED, LOCATIONS SHOWN ON C-5 & C-6	KC

APPLIED WATER ENGINEERS, INC.
130 SIO HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S. TICE
CHECKED: W. FULLERTON
SUBMITTED: Darrell Horton
CHIEF, DESIGN & STUDIES SECTION
DATE APPROVED: 2 Aug 94

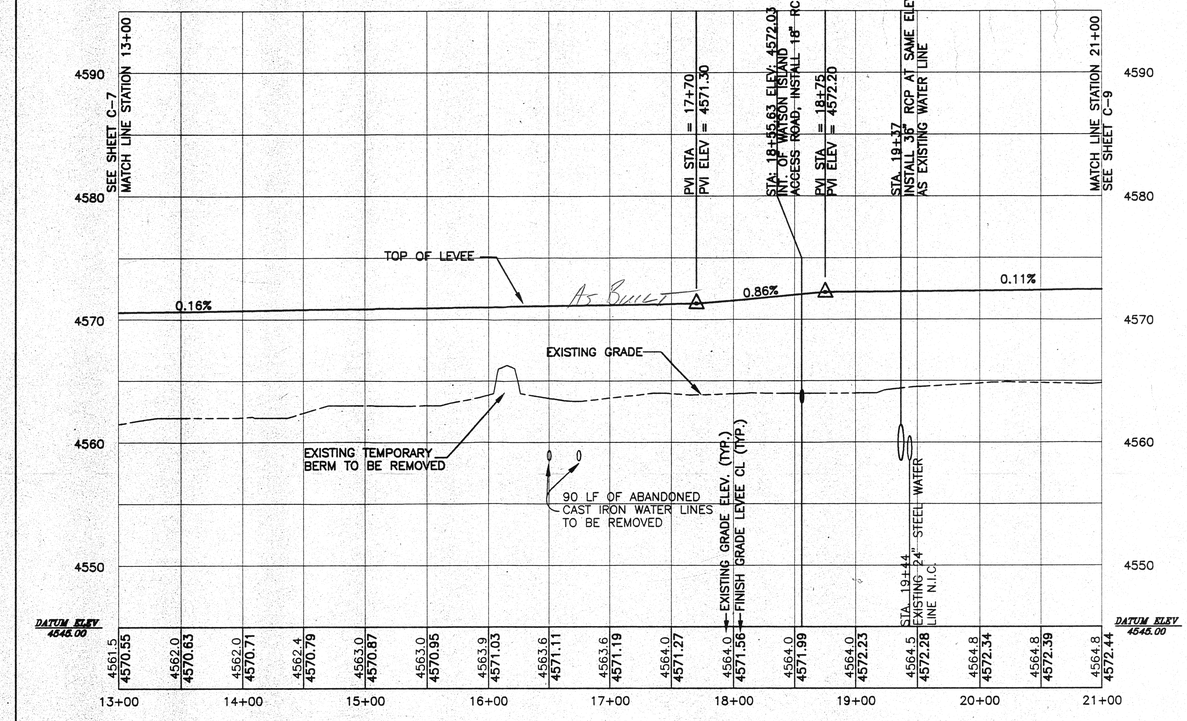
GRAND JUNCTION COLORADO

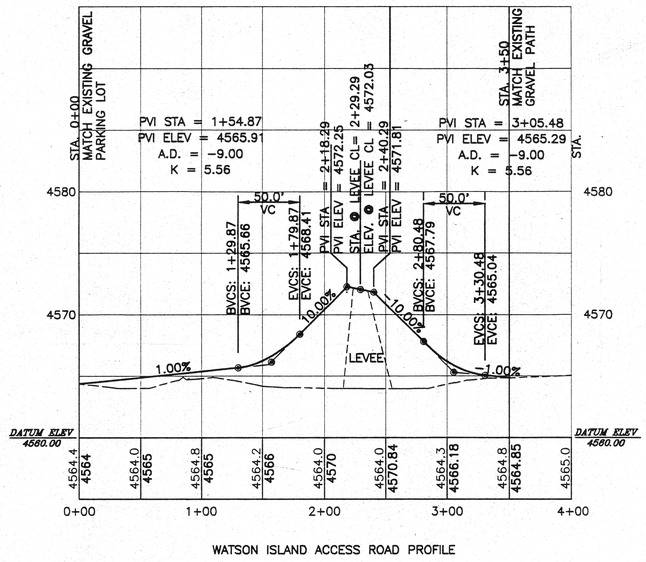
LEVEE PROJECT

PLAN & PROFILE
STA 0+00 – 13+00

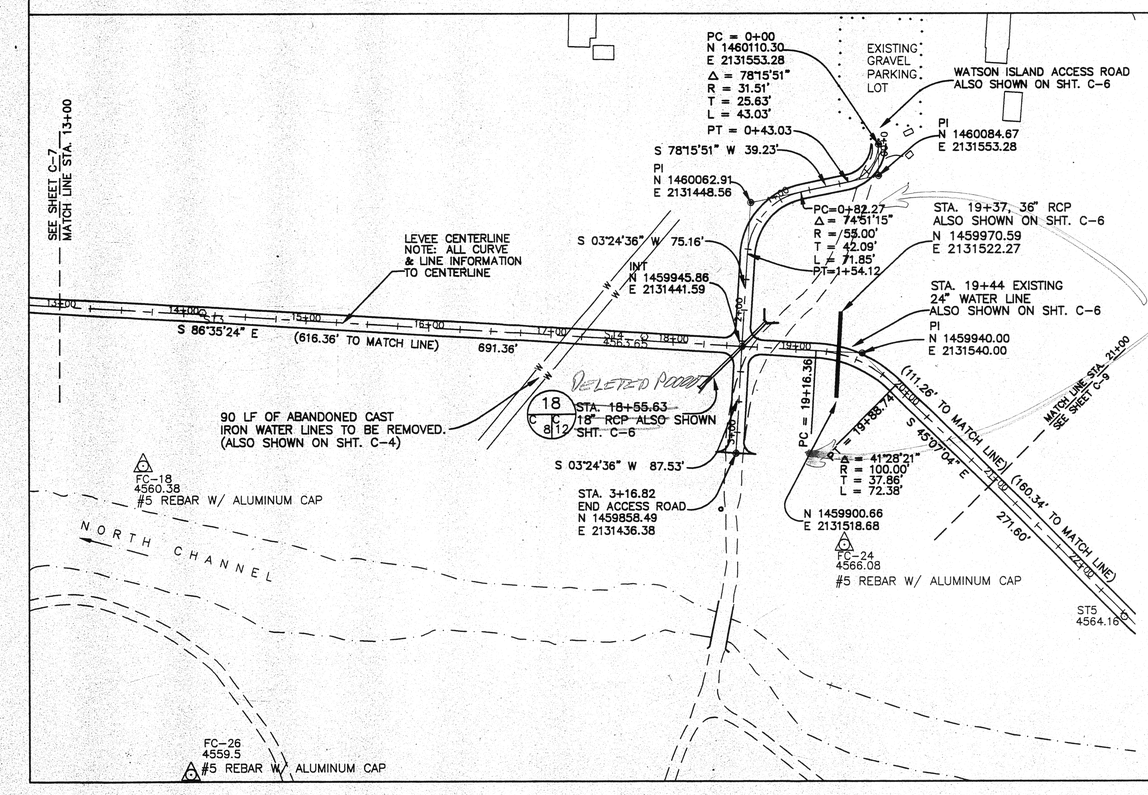
SCALE: AS SHOWN SPEC. No. 9349
SHEET C-7 8 OF 14
FILE No. 12-13-012

ARMCOND 8/17/94





WATSON ISLAND ACCESS ROAD PROFILE



ACCESS ROADS MODIFIED AS PER CANONIE & ASSOC DWG 4498 PAGE 3 See C-5a

CIVIL LEGEND OF MATERIALS - PLAN

PROPOSED	EXISTING	TO BE REMOVED	
			BUILDING
			PAVED ROADS
			GRAVEL OR DIRT ROADS
			EDGE OF WATER
3500	3500		CONTOUR LINES (5)
			CONTOUR LINES (1)
25.2			FINISH GRADE
	+25.2		SPOT ELEVATION
			SWALE OR DITCH
			RAILROAD TRACK
	SS		FORCE MAIN (SEWER)
	W	W	WATER LINE
	FH		FIRE HYDRANT
			GATE VALVE
	SS	SS	SANITARY SEWER LINE
			MANHOLE
	SD	SD	STORM DRAIN LINE
			STORM DRAIN INLET OR CATCH BASIN
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	E	E	ELECTRICAL LINE (UNDERGROUND)
	OHE	OHE	ELECTRICAL LINE (OHE=OVERHEAD ELEC.)
			POWER POLE
			LUMINAIRE
			SIGN
			WOOD FENCE
			CHAIN LINK FENCE
			WIRE MESH FENCE
			STORM DRAIN CULVERTS
			BOLLARDS
	FC-24 4566.08		PANEL CONTROL POINT
	ST5 4564.16		SOIL TEST HOLE
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			TREE LINE

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1. SEE SHEETS C-5, & C-6 FOR HORIZONTAL LOCATIONS OF EXISTING STRUCTURES ALONG LEVEE PROFILE.

N

GRAPHIC SCALES

1" = 50' 0 10' 25' 50' 100' 150' 200'

REVISION	DATE	DESCRIPTION	BY	BY

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S. TICE
CHECKED: W. FULLERTON
SUBMITTED: Darrell W Horton, CHIEF, DESIGN & STUDIES SECTION
DATE APPROVED: 2 Aug 94

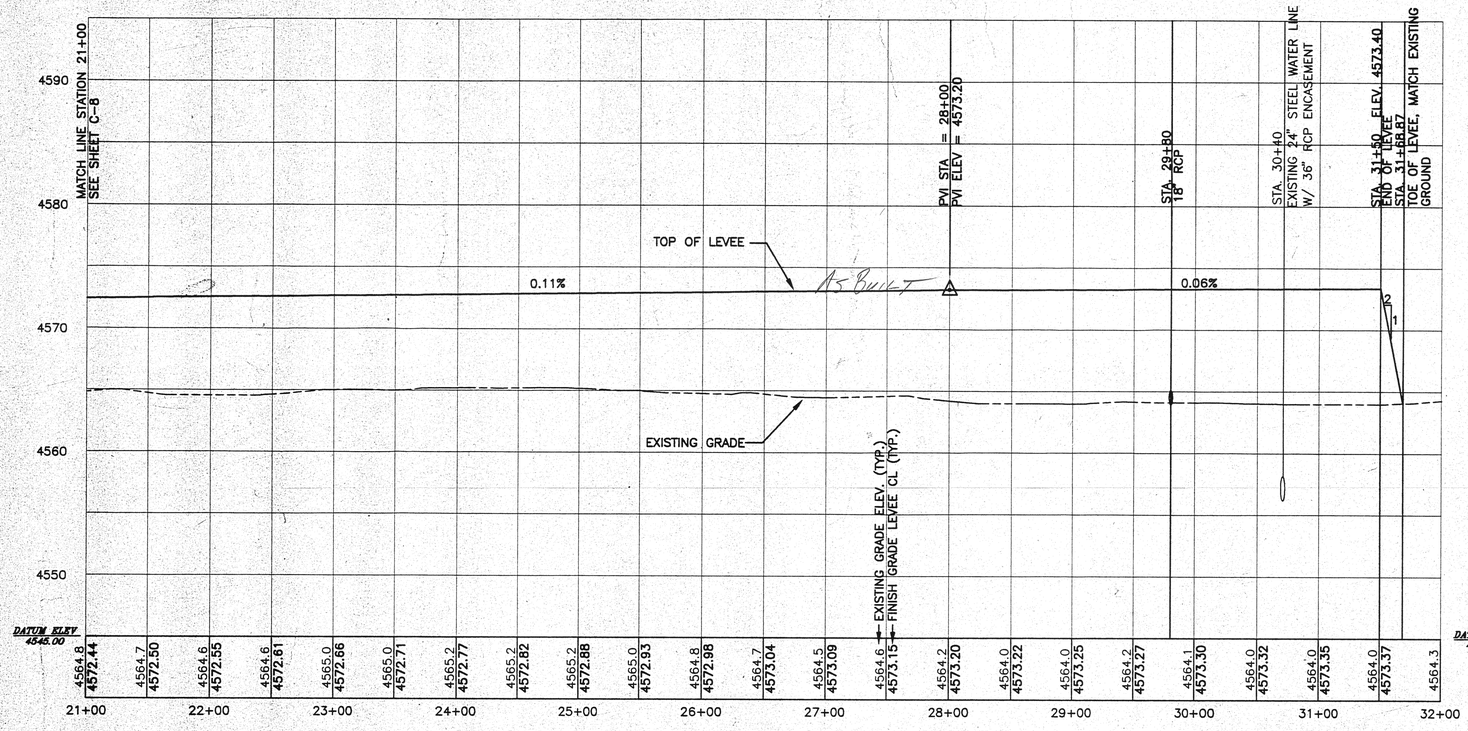
GRAND JUNCTION COLORADO

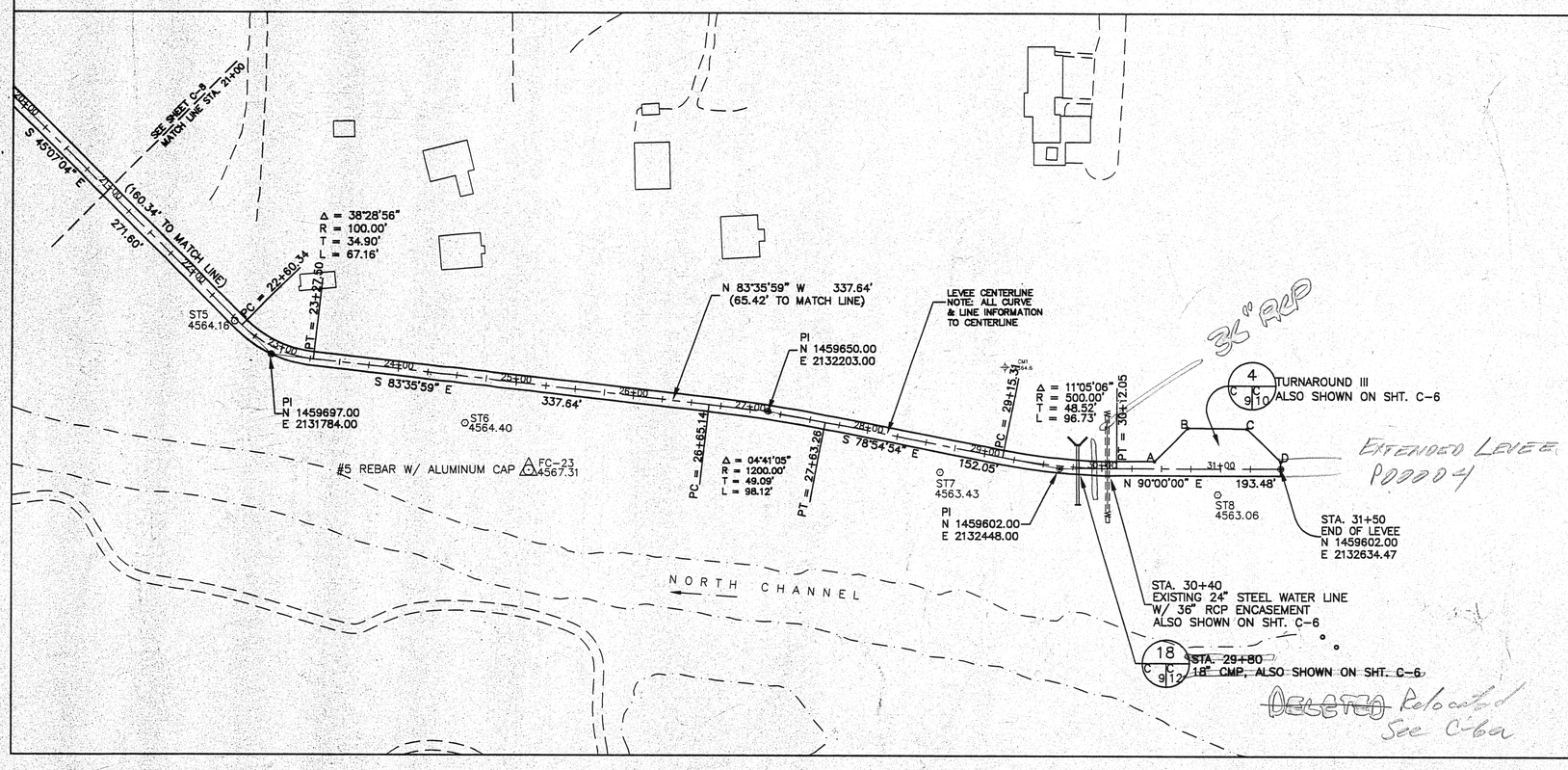
LEVEE PROJECT

PLAN & PROFILE
STA 13+00 – 21+00

SCALE: AS SHOWN SPEC. No.: 9349
SHEET: C-8 9 OF 14 FILE No.: 12-13-012

LEVEEPRO.DWG 3/7/94





CIVIL LEGEND OF MATERIALS - PLAN

PROPOSED	EXISTING	TO BE REMOVED	
			BUILDING
			PAVED ROADS
			GRAVEL OR DIRT ROADS
			EDGE OF WATER
3500	3500		CONTOUR LINES (5)
			CONTOUR LINES (1)
25.2			FINISH GRADE
	+25.2		SPOT ELEVATION
			SWALE OR DITCH
			RAILROAD TRACK
	SS		FORCE MAIN (SEWER)
	W	W	WATER LINE
	FH		FIRE HYDRANT
			GATE VALVE
	SS	SS	SANITARY SEWER LINE
			MANHOLE
	SD	SD	STORM DRAIN LINE
			STORM DRAIN INLET OR CATCH BASIN
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	G	G	GAS LINE
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			WOOD FENCE
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	ST5 4564.16		SOIL TEST HOLE
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NUMBER OF SHEET ON WHICH SECTION OR DETAIL IS DRAWN

1. SEE SHEETS C-5, & C-6 FOR HORIZONTAL LOCATIONS OF EXISTING STRUCTURES ALONG LEVEE PROFILE.

N

GRAPHIC SCALES

1" = 50' 0 10' 25' 50' 100' 150' 200'

REVISION	DATE	DESCRIPTION	BY	BY

APPLIED WATER ENGINEERS, INC.
150 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S. TICE
CHECKED: W. FULLERTON

GRAND JUNCTION COLORADO

LEVEE PROJECT

PLAN & PROFILE
STA 21+00 – 32+00

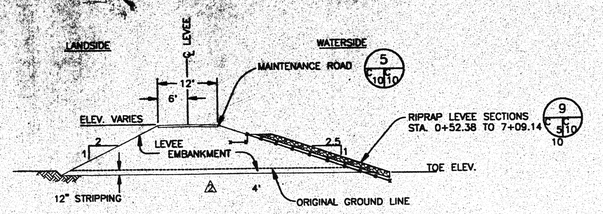
SUBMITTED: Darrell Horton
CHIEF, DESIGN & STUDIES SECTION

DATE APPROVED: 1 Aug 94

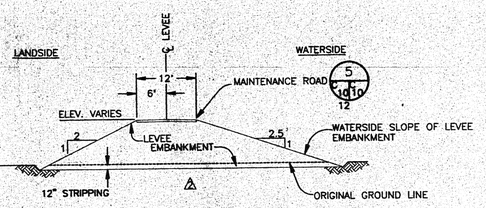
SCALE: AS SHOWN SPEC. No.: 9349
SHEET: C-9 10 OF 14
FILE No.: 12-13-012

LEVEPROJ.DWG 3/7/94

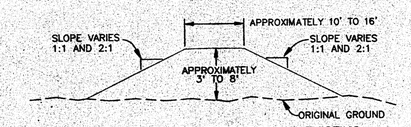
ENVIRONMENTAL ENHANCEMENT THRU ENGINEERING



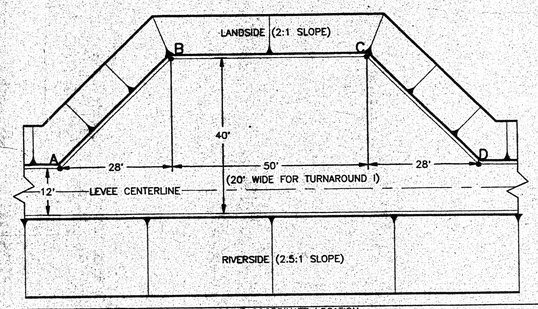
1 5/10 — TYPICAL LEVEE SECTION STA 0+52.38 TO 7+03.50
(NO SCALE)
LANDSIDE AND WATERSIDE TO BE SEEDED EXCEPT WHERE RIPRAP IS SHOWN



2 5/10 6 — TYPICAL LEVEE SECTION STA 8+30 TO 31+50
(NO SCALE)
LANDSIDE AND WATERSIDE SLOPES TO BE SEEDED PER SPECIFICATIONS

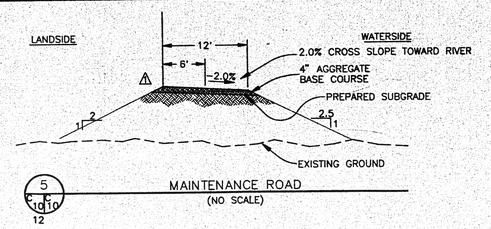


3 5/10 4 — TYPICAL CROSS SECTION OF EXISTING BERM TO BE REMOVED
(NO SCALE)

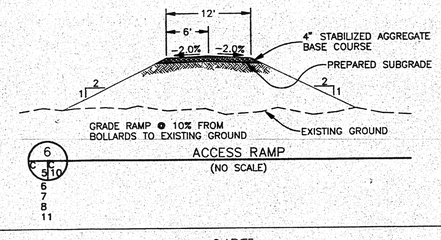


POINT COORDINATE LOCATION								
	A		B		C		D	
TURN AROUND	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING
I	1460254.24	2130297.15	1460275.24	2130330.49	1460268.74	2130349.77	1460247.98	2130363.00
II	1460213.38	2130496.90	1460217.84	2130536.55	1460188.36	2130575.40	1460146.65	2130579.26
III	1459608.00	2132528.47	1459636.31	2132556.47	1459636.11	2132606.47	1459608.00	2132634.47

4 5/10 6 7 8 9 — TURNAROUND DETAIL
(NO SCALE)



5 5/10 10 12 — MAINTENANCE ROAD
(NO SCALE)



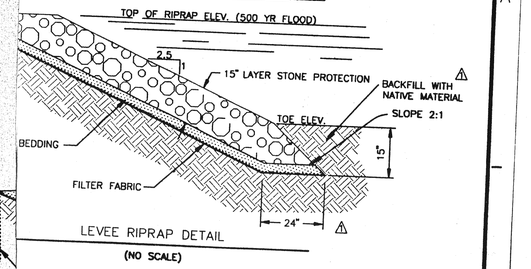
6 5/10 6 7 8 11 — ACCESS RAMP
(NO SCALE)

7 5/10 6 — INSPECTION TRENCH AT UTILITY CROSSING
(NO SCALE)
FOR PIPES WITH LESS THAN 6' OF COVER

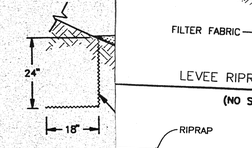
NOTE: ALL STEEL SHALL BE PAINTED WITH A RUST RESISTANT PRIMER (RED). POST SHALL BE FIELD PAINTED WITH INDUSTRIAL MAINTENANCE COATING, COLOR (SAFETY BLUE) LRV 17%.

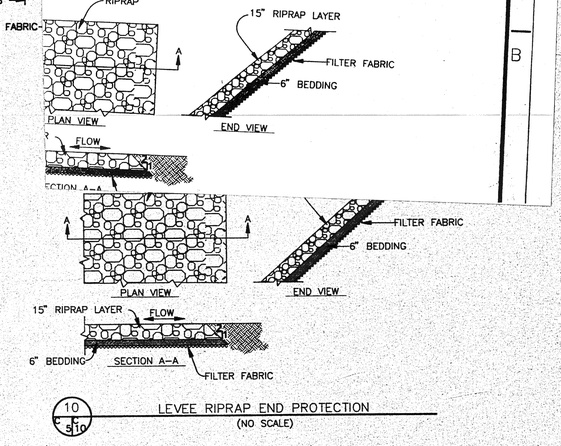
8 5/10 6 — BOLLARD DETAIL
(NO SCALE)

LEVEE RIPRAP SCHEDULE 0+52.38 TO 7+03.50			
STATION	TOE ELEV.	TOP OF RIP RAP (500 YEAR FLOOD ELEV.)	
0+52.38	4556.0	4564.9	
~~1+00~~	4556.0	40.9 4564.9	66.1
2+00	4558.0	62.1 4565.0	66.3
3+00	4559.5	61.80 4565.0	65.80
4+00	4560.0	61.20 4565.1	62.60
5+00	4560.0	62.0 4565.1	62.1
6+00	4560.5	64.9 4565.8	67.9
7+00	4558.0	63.0 4566.6	68.7
7+03.50	4556.0	63.0 4566.7	64.7

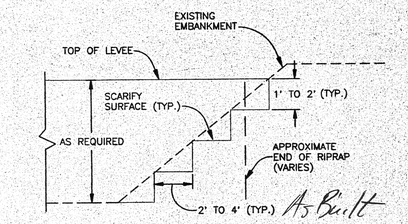


LEVEE RIPRAP DETAIL
(NO SCALE)





10 5/10 — LEVEE RIPRAP END PROTECTION
(NO SCALE)



11 5/10 — END DETAIL AT EXISTING EMBANKMENTS
(NO SCALE)

REVISION	DATE	DESCRIPTION	BY
1	09/13/94	REMOVE CORE TRENCH	EC
2	08/16/94	MISCELLANEOUS REVISIONS	RC

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD. SUITE 200
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1658

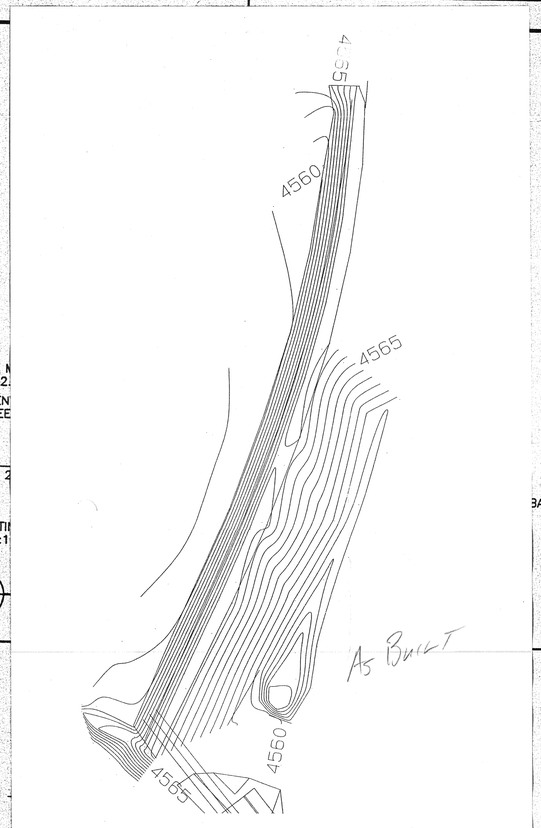
DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

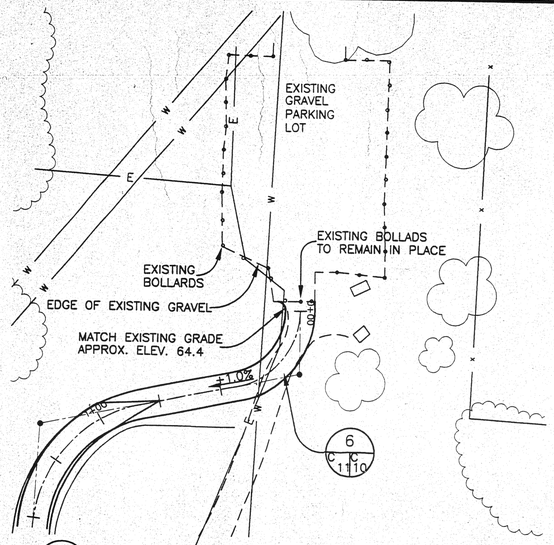
DESIGNED: P. McCARTHY
DRAWN: S. TICE
CHECKED: W. FULLERTON

GRAND JUNCTION COLORADO

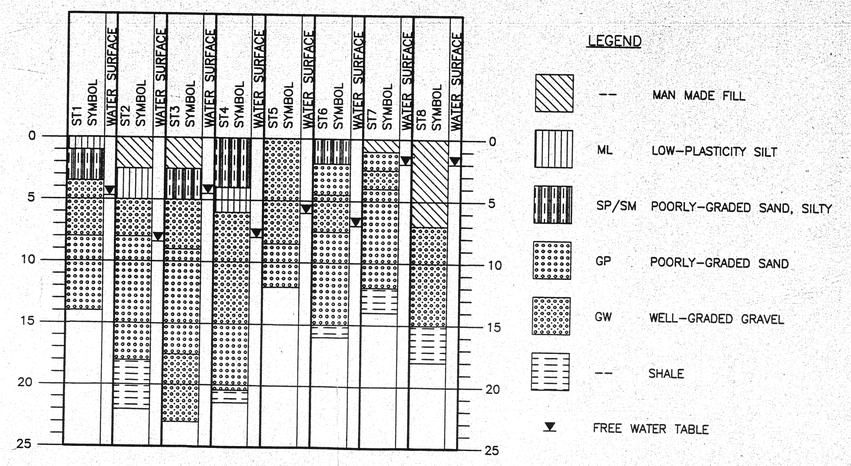
LEVEE PROJECT
DETAIL SHEET

SUBMITTED: CHIEF, DESIGN & STUDIES SECTION
DATE APPROVED: 2 Aug 94
SCALE: AS SHOWN
SHEET: C-10 11 OF 14
FILE No.: 12-13-012
SPEC. No.: 9349

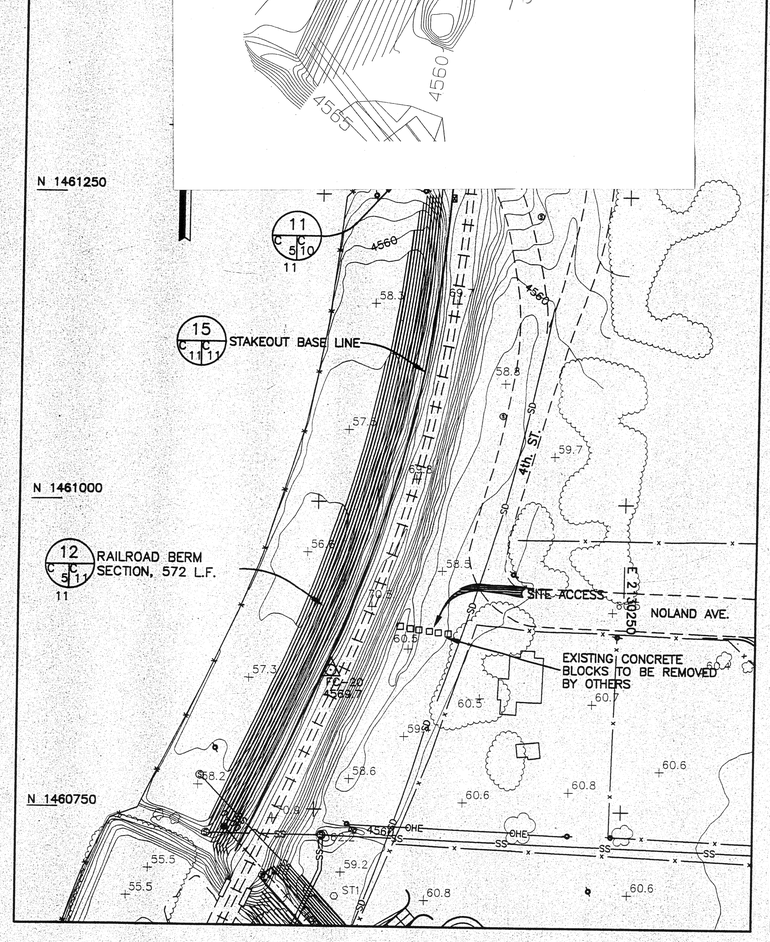




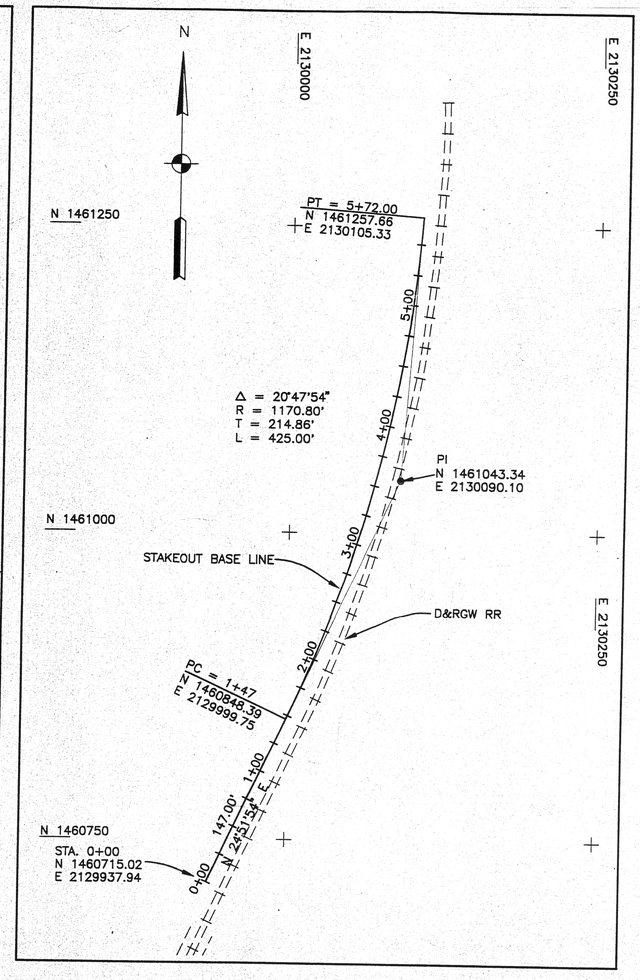
13 C 11 — WATSON ISLAND ACCESS ROAD
SCALE 1" = 20'



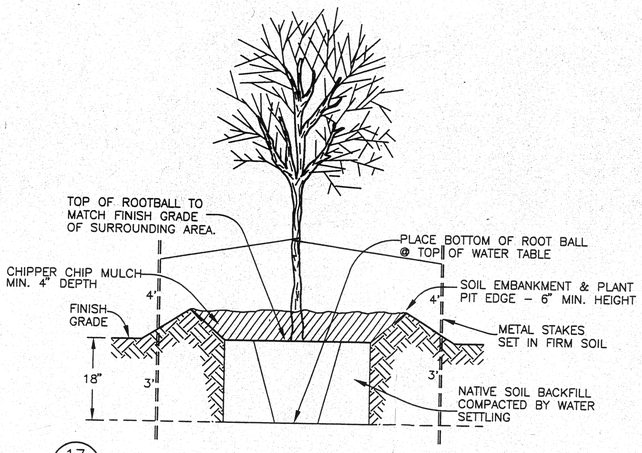
16 C 5 11 6 — BORING LOGS
(NO SCALE)



14 C 5 11 — RAILROAD BERM PLAN
SCALE 1" = 50'



15 C 11 11 — RAILROAD EMBANKMENT STAKEOUT INFO
SCALE 1" = 50'



17 C 5 11 6 — TREE PLANTING DETAIL
(NO SCALE)

TREE PLANTING LOCATION TABLE

TREE #	NORTHING	EASTING
#1	1460433.83	2130046.54
#2	1460404.35	2130010.11
#3	1460362.74	2129991.03
#4	1460329.79	2129966.75
#5	1460302.05	2130001.44
#6	1457994.09	2130513.64
#7	1459979.67	2130547.48
#8	1459944.52	2130598.95
#9	1459970.18	2130683.90
#10	1459944.51	2130653.85
#11	1459943.40	2130758.77
#12	1459905.89	2130796.30
#13	1459922.07	2130843.39
#14	1459891.18	2130891.22
#15	1459896.33	2130929.48
#16	1459854.40	2130951.55
#17	1459876.47	2130976.57
#18	1459885.29	2131021.45
#19	1459880.88	2131049.41
#20	1459863.96	2131090.62
#21	1459891.91	2131125.20
#22	1459855.14	2131122.99
#23	1459888.24	2131159.79
#24	1459855.88	2131191.42

REVISION	DATE	DESCRIPTION	BY

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S. TICE
CHECKED: W. FULLERTON

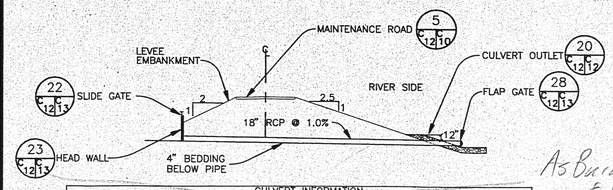
GRAND JUNCTION COLORADO
LEVEE PROJECT
DETAIL SHEET

SUBMITTED: Darrell W. Hunter
CHIEF, DESIGN & STUDIES SECTION
DATE APPROVED: 2 Aug 94

SCALE: AS SHOWN
SPEC. No.: 9343
SHEET: C-11
12 OF 14
FILE No.: 12-13-012

DETAILS.DWG 3/7/94

FUNCTIONAL



AS BUILT P00007 & P00013

CULVERT INFORMATION

	INLET			OUTLET			L,ft
CULVERT STATION	INV.	NORTHING	EASTING	INV.	NORTHING	EASTING	
STA. 0+73	4557.50	1460702.63	2129994.03	4556.50	1460646.66	2129961.48	100
STA. 11+61	4559.50	1460019.56	2130763.12	4558.90	1459968.19	2130730.54	60
STA. 18+55.63	4563.90	1459965.83	2131461.33	4563.10	1459911.43	2131407.33	80
STA. 29+79	4563.70	1459822.37	2132463.27	4563.20	1459571.54	2132463.61	50

CULVERT DETAIL

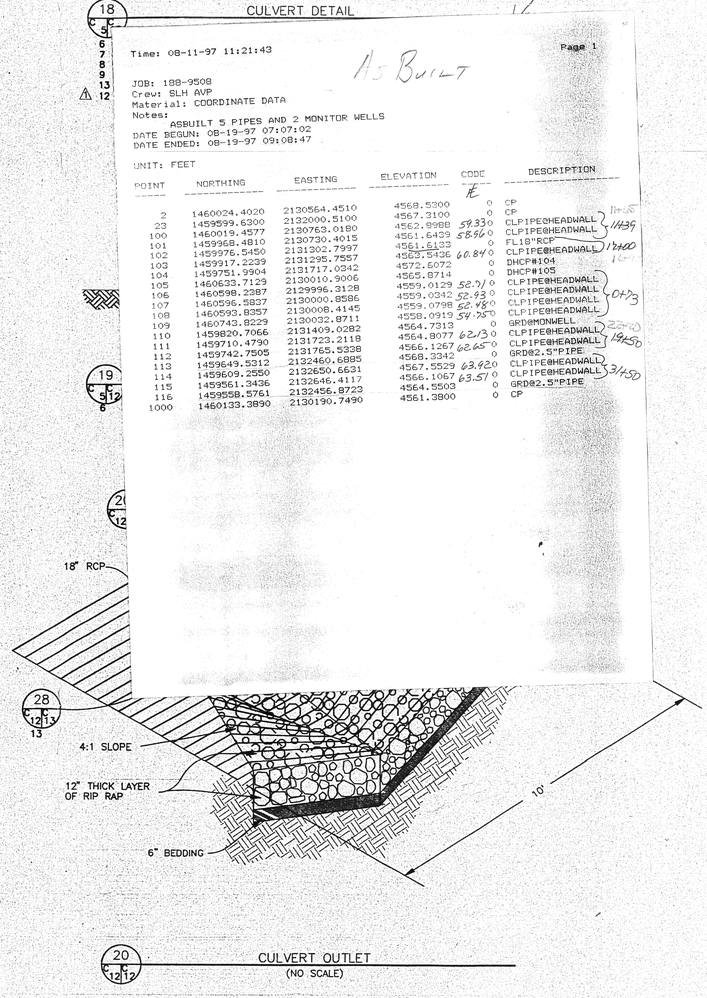
Time: 08-11-97 11:21:43 — Page 1

AS BUILT

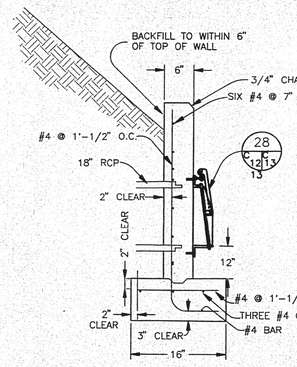
JOB: 188-9508
Crew: SLH AVP
Material: COORDINATE DATA
Notes:
ASBUILT 5 PIPES AND 2 MONITOR WELLS
DATE BEGUN: 08-19-97 07:07:02
DATE ENDED: 08-19-97 09:08:47

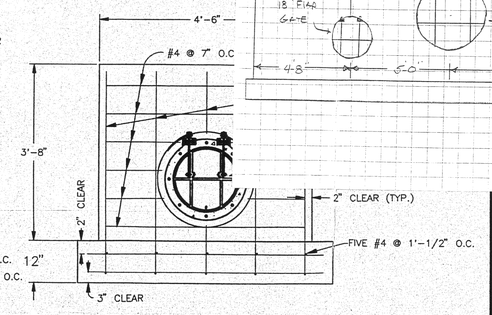
UNIT: FEET

POINT	NORTHING	EASTING	ELEVATION	CODE	DESCRIPTION
				E	
2	1460024.4020	2130564.4510	4568.5300	0	CP
23	1459599.6300	2132000.5100	4567.3100	0	CP
100	1460019.4577	2130763.0180	4562.9988	57.33	CLP1PE@HEADWALL
101	1459968.4810	2130730.4015	4561.6439	58.86	CLP1PE@HEADWALL
102	1459976.5450	2131302.7997	4561.6133	60.84	FL18"RCP
103	1459917.2239	2131295.7557	4563.5436	0	CLP1PE@HEADWALL
104	1459751.9904	2131717.0342	4572.5072	0	DHCP#104
105	1460633.7129	2130010.9006	4565.8714	0	DHCP#105
106	1460598.2387	2129996.3128	4559.0129	52.7	CLP1PE@HEADWALL
107	1460596.5827	2130000.8586	4559.0342	52.93	CLP1PE@HEADWALL
108	1460593.8357	2130008.4145	4559.0798	52.48	CLP1PE@HEADWALL
109	1460743.8229	2130032.8711	4558.0919	54.73	GRD@MONWELL
110	1459820.7066	2131409.0282	4564.7313	0	CLP1PE@HEADWALL
111	1459710.4790	2131723.2118	4564.8077	62.13	CLP1PE@HEADWALL
112	1459742.7505	2131765.5338	4566.1267	62.65	GRD@2.5"PIPE
113	1459649.5312	2132460.6885	4568.3242	0	CLP1PE@HEADWALL
114	1459609.2550	2132650.6631	4567.5529	63.92	CLP1PE@HEADWALL
115	1459561.3436	2132646.4117	4566.1067	63.57	GRD@2.5"PIPE
116	1459558.5761	2132456.8723	4564.5503	0	CP
1000	1460133.3890	2130190.7490	4561.3800	0	CP

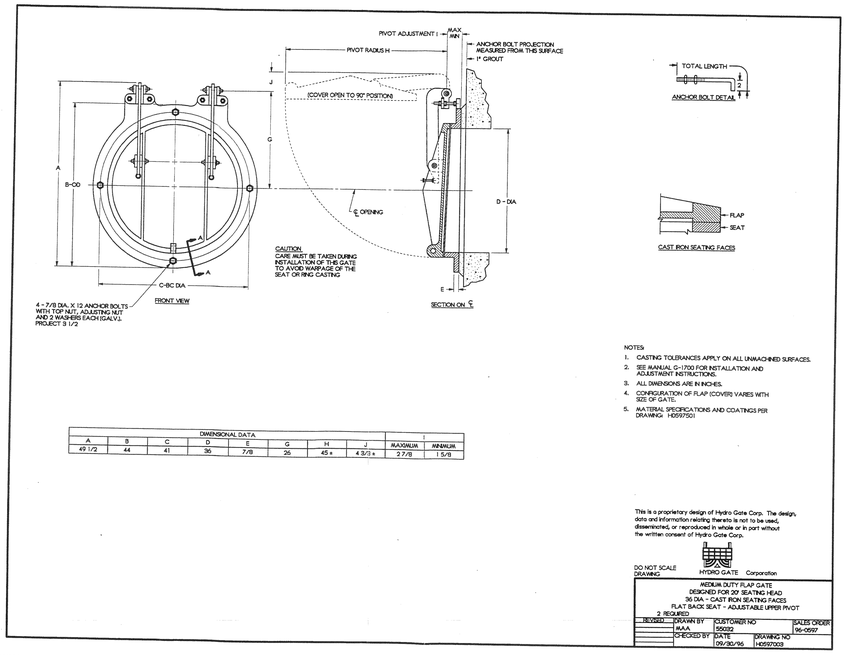


CULVERT OUTLET
(NO SCALE)





CULVERT OUTLET HEAD WALL
(NO SCALE)



DIMENSIONAL DATA									
A	B	C	D	E	G	H	J	MAXIMUM	MINIMUM
49 1/2	44	41	36	7/8	26	45°	4 3/8	2 7/8	1 5/8

NOTES
1. CASTING TOLERANCES APPLY ON ALL UNMACHINED SURFACES.
2. SEE MANUAL G-1700 FOR INSTALLATION AND ADJUSTMENT INSTRUCTIONS.
3. ALL DIMENSIONS ARE IN INCHES.
4. CONFIGURATION OF FLAP (COVER) VARIES WITH SIZE OF GATE.
5. MATERIAL SPECIFICATIONS AND COATINGS PER DRAWING 14597501

DO NOT SCALE DRAWING

HYDRO GATE Corporation

MEDIUM DUTY FLAP GATE
DESIGNED FOR 20' SEATING HEAD
36 DIA - CAST IRON SEATING FACES
FLAT BACK SEAT - ADJUSTABLE UPPER PIVOT
2 REQUIRED

REVISED	DRAWN BY	CUSTOMER NO	SALES ORDER
	MAA	150032	96-0597
	CHECKED BY	DATE	DRAWING NO
		09/30/96	14597003

GRADE A CONSTANT, SMOOTH SLOPE FROM UPPER LIMITS OF DETENTION BASIN TO CULVERT INLET.

DETENTION BASIN POINT LOCATIONS

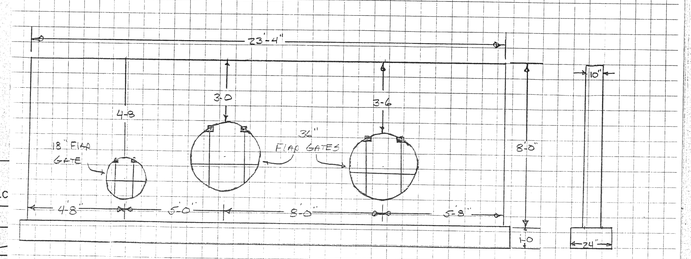
POINT LOCATION NUMBER	DETENTION BASIN I		DETENTION BASIN II		DETENTION BASIN III	
	NORTHING	EASTING	NORTHING	EASTING	NORTHING	EASTING
1	1460691.97	2130011.35	1460017.67	2130769.23	1459628.72	2132471.45
2	1460683.34	2130049.70	1460004.4			
3	1460683.55	2130030.90	1460004.4			
4	1460852.50	2130088.00	1460075.0			
5	1460880.18	2130098.18	1460113.8			
6	1460886.42	2130094.68	1460138.9			
7	1460872.62	2130068.87	1460156.6			
8	1460872.62	2130065.64	1460156.0			
9	1460725.06	2130005.71	1460137.8			
10	1460712.56	2130000.70	1460096.4			
11			1460065.7			
12			1460027.1			

DETENTION

(NO SC

MODIFIED
CULVERT OUTLET HEAD WALL
RADOX STATION 0+73

REBAR AS PER ZOA / C-12



REVISION	DATE	DESCRIPTION	BY	BY
1	10/14/96	MISCELLANEOUS REVISION	KC	Kevin
2	09/12/94	MISCELLANEOUS REVISION	KC	Kevin

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD., SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S. TICE
CHECKED: W. FULLERTON

GRAND JUNCTION COLORADO

LEVEE PROJECT

DETAIL SHEET

SUBMITTED: Darrell W. Hunter
CHIEF, DESIGN & STUDIES SECTION

DATE APPROVED: 2 Aug 94

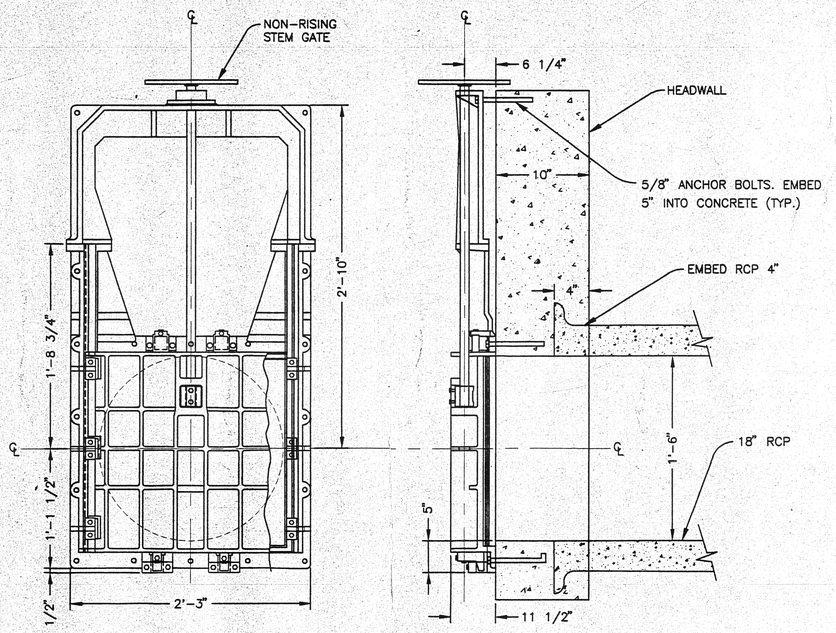
SCALE: AS SHOWN | SPEC No.: 9349
SHEET: C-12 | FILE No.: 12-13-012
13 OF 14

DETAILS.DWG 8/19/94

ENVIRONMENTAL ENHANCEMENT THRU ENGINEERING

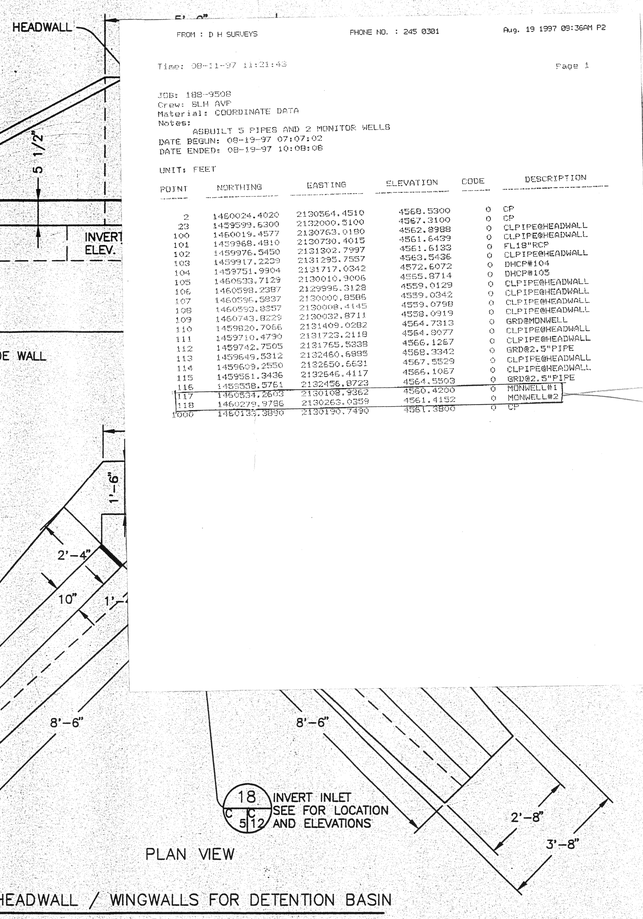
SAFETY PAYS

1 2 3 4 5



22 C 12 C 13 SLIDE GATE & HEADWALL DETAIL

(NO SCALE)



18 C 5 C 12 INVERT INLET SEE FOR LOCATION AND ELEVATIONS

23 C 12 C 13 HEADWALL / WINGWALLS FOR DETENTION BASIN

(NO SCALE)

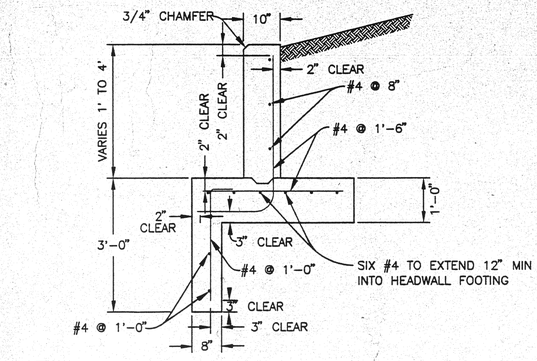
FROM : D H SURVEYS PHONE NO. : 245 0301 Aug. 19 1997 09:36AM P2

Time: 08-11-97 11:21:43 Page 1

JOB: 188-9508
Crew: SLM AVP
Material: COORDINATE DATA
Notes: ASBUILT 5 PIPES AND 2 MONITOR WELLS
DATE BEGUN: 08-19-97 07:07:02
DATE ENDED: 08-19-97 10:08:08

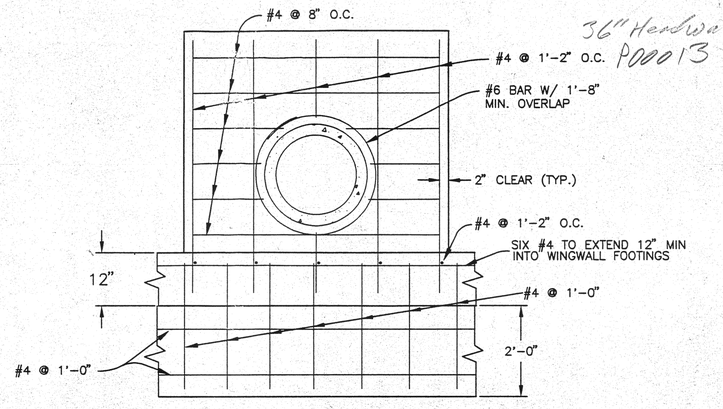
UNIT: FEET

POINT	NORTHING	EASTING	ELEVATION	CODE	DESCRIPTION
2	1460024.4020	2130564.4510	4568.5300	0	CP
23	1459999.5300	2132000.5100	4567.3100	0	CP
100	1460019.4577	2130763.0190	4562.8988	0	CLP1PE@HEADWALL
101	1459968.4810	2130730.4015	4561.6429	0	FL18"RCP
102	1459976.5450	2131302.7997	4561.6133	0	CLP1PE@HEADWALL
103	1459917.2229	2131295.7557	4563.5436	0	DHCP#104
104	1459751.9304	2131717.0342	4572.6072	0	DHCP#105
105	1460533.7129	2130010.9006	4555.8714	0	CLP1PE@HEADWALL
106	1460598.2387	2129995.3128	4559.0129	0	CLP1PE@HEADWALL
107	1460596.5837	2130000.8505	4559.0342	0	CLP1PE@HEADWALL
108	1460590.8357	2130008.4145	4559.0798	0	CLP1PE@HEADWALL
109	1460743.8229	2130032.8711	4558.0919	0	GRD@MONWELL
110	1459820.7066	2131409.0282	4564.7313	0	CLP1PE@HEADWALL
111	1459710.4790	2131723.2118	4564.3977	0	CLP1PE@HEADWALL
112	1459742.7505	2131765.5338	4566.1267	0	CLP1PE@HEADWALL
113	1459649.5312	2132460.6895	4568.3342	0	GRD@2.5"PIPE
114	1459609.2550	2132650.5621	4567.5529	0	CLP1PE@HEADWALL
115	1459581.3436	2132646.4117	4566.1067	0	GRD@2.5"PIPE
116	1459538.5761	2132456.8723	4564.5503	0	MONWELL#1
117	1460534.2603	2130108.9362	4560.4200	0	MONWELL#2
118	1460279.9786	2130263.0359	4561.4152	0	CP
1000	1460139.3890	2130190.7490	4561.3800	0	CP



24 C 13 C 13 BAR PLACEMENT AT WINGWALL

(NO SCALE)

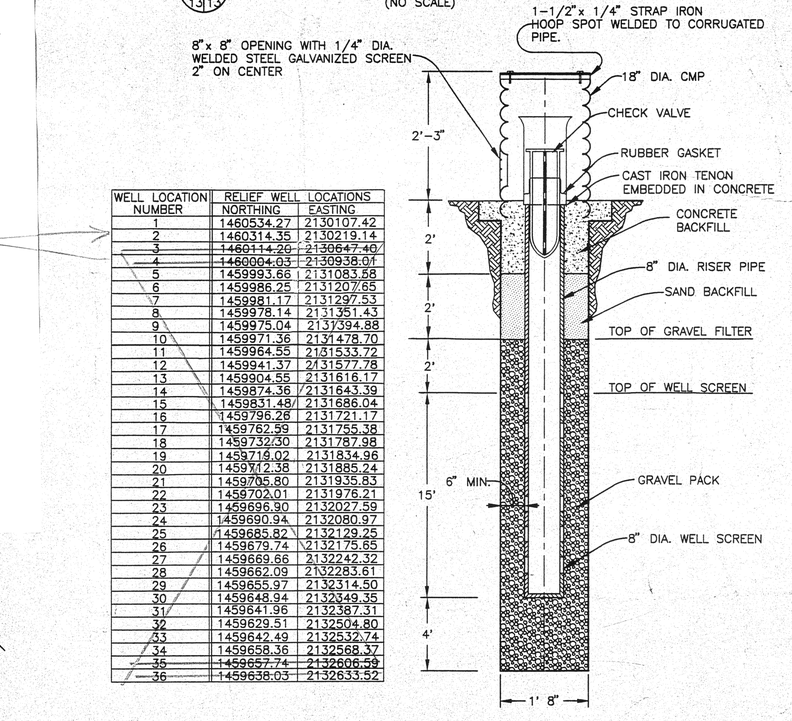


25 C 13 C 13 BAR PLACEMENT AT HEADWALL

(NO SCALE)

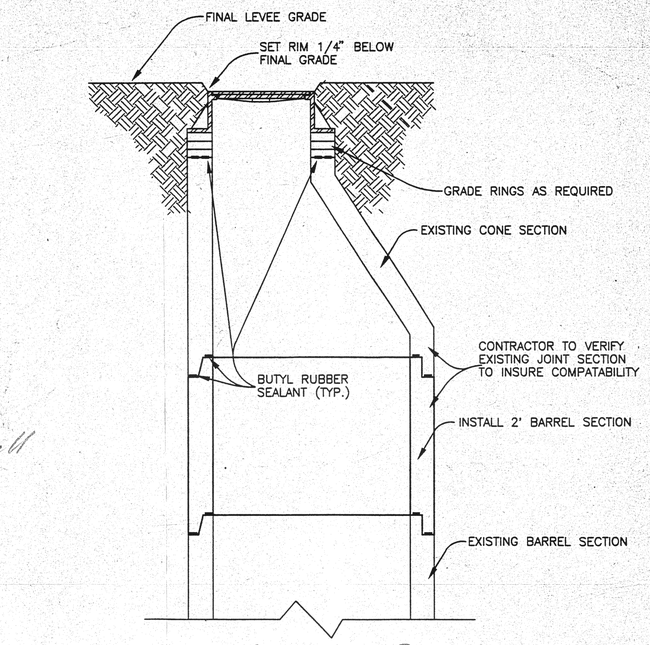
36" Headwall P00013

WELL LOCATION NUMBER	RELIEF WELL LOCATIONS NORTHING	EASTING
1	1460534.27	2130107.42
2	1460314.35	2130219.14
3	1460114.20	2130647.40
4	1460004.03	2130938.01
5	1459993.66	2131083.58
6	1459986.25	2131207.65
7	1459981.17	2131297.53
8	1459978.14	2131351.43
9	1459975.04	2131394.88
10	1459971.36	2131478.70
11	1459964.55	2131533.72
12	1459941.37	2131577.78
13	1459904.55	2131616.17
14	1459874.36	2131643.39
15	1459831.48	2131686.04
16	1459796.26	2131721.17
17	1459762.59	2131755.38
18	1459732.30	2131787.98
19	1459719.02	2131834.96
20	1459712.38	2131885.24
21	1459705.80	2131935.83
22	1459702.01	2131976.21
23	1459696.90	2132027.59
24	1459690.94	2132080.97
25	1459685.82	2132129.25
26	1459679.74	2132175.65
27	1459669.66	2132242.32
28	1459662.09	2132283.61
29	1459655.97	2132314.50
30	1459648.94	2132349.35
31	1459641.96	2132387.31
32	1459629.51	2132504.80
33	1459642.49	2132532.74
34	1459658.36	2132568.37
35	1459657.74	2132606.59
36	1459638.03	2132633.52



26 C 13 C 13 RELIEF WELL DETAIL

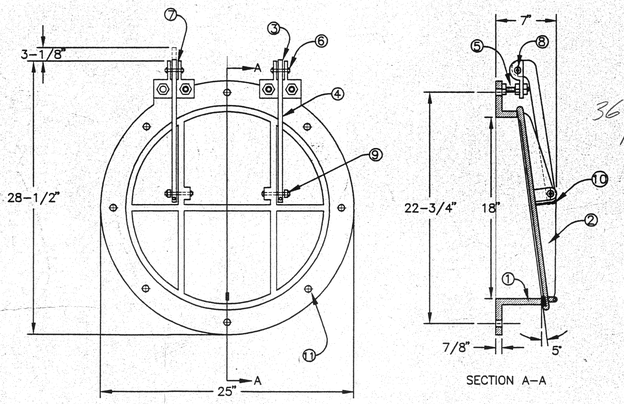
(NO SCALE)



DELETED

27 C 5 C 13 MANHOLE RIM EXTENTION

(NO SCALE)



36" Dimensions P00013

SECTION A–A

① FRAME
② COVER
③ PIVOT LUG
④ HINGE LINK
⑤ HINGE STUDS & NUTS
⑥ HINGE PIN
⑦ HINGE BUSHING
⑧ WASHERS
⑨ SPRING PIN
⑩ SET SCREW
⑪ BOLT ø = 5/8", PROJ. = 1-1/2" HEAVEY DUTY ANCHOR BOLT DRILLED INTO CONCRETE HEADWALL

28 C 12 C 13 FLAP GATE

(NO SCALE)

REVISION	DATE	DESCRIPTION	BY	BY

APPLIED WATER ENGINEERS, INC.
130 SKI HILL RD. SUITE 250
BRECKENRIDGE, CO 80424 (303)453-7545
P.O. BOX 1659

DEPARTMENT OF THE ARMY
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

DESIGNED: P. McCARTHY
DRAWN: S. TICE
CHECKED: W. FULLERTON

GRAND JUNCTION COLORADO

LEVEE PROJECT

DETAIL SHEET

SUBMITTED: Darrell W Horton
CHIEF, DESIGN & STUDIES SECTION

DATE APPROVED: 2 Aug 94

SCALE: AS SHOWN SPEC. No.: 9349
SHEET: C-13 14 OF 14
FILE No.: 12-13-012

DETAILING 3/7/94

ENVIRONMENTAL ENHANCEMENT THRU ENGINEERING