Request for Proposal
RFP-4519-18-DH

Professional Services for Safety Evaluation of Hogchute Dam

RESPONSES DUE:
May 4, 2018 prior to 3:30 PM MST
Accepting Electronic Responses Only
Responses Only Submitted Through the Rocky Mountain E-Purchasing System (RMEPS)
https://www.rockymountainbidsystem.com/default.asp
(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)

PURCHASING REPRESENTATIVE:
Duane Hoff, Senior Buyer
duaneh@gjcity.org
(970) 244-1545

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

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:
Duane Hoff, Senior Buyer
duaneh@gjcity.org

1.2 Purpose: The purpose of this RFP is to obtain proposals from qualified professional firms to perform a dam safety evaluation and identify Potential Failure Modes (PFM) on the City of Grand Junction's Hogchute (aka: Carson) Reservoir dam.

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

1.4 Pre-Proposal Meeting: A site visit is not scheduled for this Request for Proposal due to winter conditions. A pre-proposal meeting will not be offered.

1.5 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.

1.6 Submission: Please refer to section 5.0 for what is to be included. ***Each proposal shall be submitted in electronic format only, and only through the Rocky Mountain E-Purchasing website (https://www.rockymountainbidsystem.com/default.asp).*** *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/business-and-economic-development/bids/ for details. For proper comparison and evaluation, the City requests that proposals be formatted as directed in Section 5.0 "Preparation and Submittal of Proposals." Submittals received that fail to follow this format may be ruled non-responsive. (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**).

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 Purchasing Division. 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.rockymountainbidsystem.com. 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 work 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 in the City Hall Auditorium, 250 North 5th Street, Grand Junction, CO, 81501, immediately following the proposal deadline. Offerors, their representatives and interested persons may be present. 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 Contractor. By executing the contract, the Contractor represents that they have familiarized themselves with the local conditions under which the Work 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 work 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 Contractor shall secure and pay for all permits, governmental fees and licenses necessary for the proper execution and completion of the work. The Contractor shall give all notices and comply with all laws, ordinances, rules, regulations and orders of any public authority bearing on the performance of the work. If the Contractor 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 Contractor performs any work 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 Work: The Contractor shall be responsible to the Owner for the acts and omissions of all his employees and all other persons performing any of the work under a contract with the Contractor.

2.5. Payment & Completion: The Contract Sum is stated in the Contract and is the total amount payable by the Owner to the Contractor for the performance of the work under the Contract Documents. Upon receipt of written notice that the work 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 work 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 Contractor, of the value of Work performed and materials placed in accordance with the Contract Documents. The work performed by Contractor 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 work in the applicable community. The work and services to be performed by Contractor hereunder shall be done in compliance with applicable laws, ordinances, rules and regulations.

2.6. Protection of Persons & Property: The Contractor 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. Contractor 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 Contractor in the execution of the work, or in consequence of the non-execution thereof by the Contractor, 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 Work: The Owner, without invalidating the contract, may order changes in the work within the general scope of the contract consisting of additions, deletions or other revisions. All such changes in the work 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 Contractor signed by

the Owner issued after the execution of the contract, authorizing a change in the work or an adjustment in the contract sum or the contract time.

2.8. Minor Changes in the Work: The Owner shall have authority to order minor changes in the work 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 Work: The Contractor shall promptly correct all work found by the Owner as defective or as failing to conform to the contract documents. The Contractor shall bear all costs of correcting such rejected work, 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 work under the above paragraphs shall be removed from the site where necessary and the work 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 work furnished hereunder shall not in any way relieve the proposer of their present responsibility to maintain the high quality, integrity and timeliness of his work. 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. Contractor 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 Contractor herby certifies that the Contractor 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 work to be done or information that comes to the attention of the Offeror during the course of performing such work 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 work 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 workers 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, subcontractor 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 can not 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 Contractor 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 Contractor 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 Contractor 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 "Work" includes all labor, materials, equipment, and/or services necessary to produce the requirements of the Contract Documents.

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

2.43.4. "Sub-Contractor is a person or organization who has a direct contract with the Contractor to perform any of the work at the site. The term sub-contractor 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 Subcontractor 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 insurance to cover obligations imposed by applicable laws for any employee engaged in the performance of work under this Contract, and Employers' Liability insurance with minimum limits of:

ONE MILLION DOLLARS ($1,000,000) each accident,
ONE MILLION DOLLARS ($1,000,000) disease - policy limit, and
ONE MILLION DOLLARS ($1,000,000) disease - each employee

(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 contractor 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 Work. The policy shall contain a severability of interest's 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 Contractor. The Contractor 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 City of Grand Junction owns and operates Hogchute Reservoir (aka: Carson Reservoir), DAMID 420127. Hogchute Reservoir is located in Mesa County, Colorado within the Grand Mesa National Forest on Kannah Creek. The reservoir was approved for construction in May of 1947 by the State Engineer with construction of the dam being completed in November 1947.

The elevation of the reservoir site is approximately 9,800 feet AMSL. The structural height of the dam is 56-ft with a normal storage capacity of 637 acre-feet of water behind an earthen embankment situated across the natural drainage path of Kannah Creek. The reservoir provides water storage for domestic use, downstream irrigation use, and for fishing recreation.

The Hogchute Reservoir dam is classified as a high hazard jurisdictional dam as defined by Colorado Dam Safety of the Division of Water Resources. A high hazard rating was given to Hogchute in the year 2015 as a result of completion of an inundation mapping study that took into account new residential development downstream of the reservoir. Currently, the dam is rated as "Conditionally Satisfactory". As a result, all work performed on the dam is subject to review and approval by the State Dam Safety Engineer. The dam has a concrete emergency spillway structure (poor condition) located on the north side of the embankment (right end of dam) that discharges into an earth-lined open channel. Water is supplied to Hogchute Reservoir from the upper reaches of the Kannah Creek drainage basin which is estimated at 6,240 acres, as well as, a natural spring with average inflows of 1.8 cfs.

Hogchute Reservoir is typically at full capacity by June 1st in a normal precipitation year with snow melt and the natural spring providing the inflows. The reservoir is usually drained to about 300 – 400 ac-ft during the winter months to accommodate the inflows from snow melt and the natural spring inflows. Currently, the reservoir has no storage level restrictions and is classified as "Conditional Full Storage".

The City has been working with the Water Division 4, Dam Safety Engineer on a Comprehensive Dam Safety Evaluation Report. This report provides an initial look into

potential failure modes (PFM) that this structure could develop or has developed. The Comprehensive Dam Safety Evaluation Report is included as part of this RFP and is provided as a tool/resource to help the consultant with identifying items that may need to be studied in more detail and to collect more detailed information about the dam conditions and increase the confidence level of the PFM analysis, and advance the dam safety evaluation. The results of this dam safety evaluation will serve as the basis for scoping dam rehabilitation work. The consultant shall also determine if there are any other PFM's not identified in the Comprehensive Dam Safety Evaluation Report based on data collected during this study.

Based on the 1947 construction drawings, which are included within, the reservoir's outlet works is controlled by two 20" hydraulically operated gate valves. The two gate valves in operation today are believed to be the original valves and are fully operational. However, it is currently unknown if the valves provide a water tight seal when in the closed position. Each valve is attached to a 20" I.D. welded steel pipe within the trash-rack structure with 2" air vent pipes at each valve. Both 20" steel pipes join together into one 30" I.D. welded steel outlet pipe about 18-ft downstream of the valves. The outlet capacity is rated at 134 cfs.

The 1947 construction drawings also show a 12" emergency gate valve that is located between the two 20" gate valves. Currently, the City doesn't know if this 12" gate valve is still in-place or if it has been removed and plated off. In the valve control house, there is no hydraulic devices or equipment that would suggest this 12" gate valve is operational.

The current valve control house is located on the crest of the dam. The dam crest is not the original location for the valve control house. The original valve control house was located at the outfall structure on the downstream side of the dam. The foundation of the old valve control house is still there today. The valve control house was relocated to the dam crest and new hydraulic piping installed to the gate valves in 1988. It's unknown at this time how the old hydraulic piping from the original valve control house was abandoned and if this abandoned piping is contributing to seepage through the dam structure.

The City of Grand Junction, in cooperation with the Colorado Dam Safety, is seeking to investigate, identify and document the seepage conditions of the dam embankment, and the operation of the outlet works. As a result, the City of Grand Junction is requesting proposals from qualified applicants to perform this evaluation.

4.2. Special Conditions/Provisions:

- **Price/Fees:** Pricing shall be established as <u>"a cost not to exceed price"</u>, and shall be all inclusive, to include, but not be limited to: labor, materials, equipment, travel, drawings, engineering work, shipping/freight, licenses, permits, fees, etc.

  Provide a not to exceed price using Solicitation Response Form found in Section 7, **<u>accompanied by a complete list of costs breakdown.</u>**

  All fees will be considered by the Owner to be <u>negotiable</u>.

- **Attached Documents:**
    1. Hogchute (Carson) Reservoir Vicinity Map
    2. State Dam Safety Engineer's Inspection Report – October 2017
    3. 1947 Construction Plans (Colo. Dam Safety Drawing C-454)
    4. State of Colorado, Comprehensive Dam Safety Evaluation Report (2018)

All designs shall be in accordance with applicable state and federal regulations, accepted standard practices, and the State of Colorado's Rules and Regulations for Dam Safety and Dam Construction (2007).

In the fall of 2017, the City of Grand Junction completed a comprehensive site survey of the dam, spillway, and outlet structures. This survey data, along with the control points, will be available to the consultant.

Consultant is responsible for identifying and acquiring all U.S. Army Corps, U.S. Forest Service, and State Engineer's Office permits as determined necessary for this evaluation.

- **Proposed Schedule:**

1. Hogchute Reservoir expected to at or near full-capacity – June, 2018.
2. Start Dam Safety Evaluation Study – June, 2018.
3. Consultant completes Task 1 and Task 2 field work as described in Section 4.3 during June, July, and August, 2018.
4. Start draining Hogchute Reservoir in early August, 2018. Depending on reservoir pool level, it's anticipated to take 6 – 8 weeks to drain Hogchute.
5. Consultant completes Task 3 field work while reservoir is empty in September and October, 2018.
6. Consultant submits Dam Safety Evaluation Report to City on December 3, 2018.
7. Consultant schedules meeting with the Colo. Dam Safety Office, Division 4 and the City to review and discuss the PFM's that were determined to need rehabilitation and/or repair. This meeting will be scheduled for mid-December, 2018.
8. Winter of 2019, City advertises a RFP for Consultant selection to design and produce a construction package with plans and specifications that will address the PFM's. Construction plans and specifications completed by the end of 2019. *(Not Part of this current RFP)*
9. Construction of improvements to Hogchute Reservoir's dam begins in June, 2020. *(Not Part of this current RFP)*

4.3. Specifications/Scope of Services:

Phased Investigation:

- **Task 1 – Hydraulic Capacity Evaluation:**

A. Perform a hydrology study using the Colorado/New Mexico REPS tool (available for public use at the end of June 2018) to determine the probable maximum flood (PMF) and evaluate the adequacy of the existing spillway

structure and determine if the reservoir's spillway needs to be resized. With the dam recently reclassified to a High Hazard structure, the spillway needs to be evaluated to verify it has the required capacity for passing the PMF. Provide necessary spillway area required to pass the PMF volume.

B. Prepare a hydrologic report for Hogchute Reservoir.

- **Task 2 – Geotechnical Investigation and Seepage Analysis:**

A. Perform these tasks with the reservoir at full or near full capacity.
B. Install piezometers to monitor phreatic water surface within the dam. The location, quantity, and depth of piezometers installed shall be determined by the consultant. Establish a monitoring baseline for a full reservoir.
C. Collect embankment material samples at different elevations during piezometer installation operations in order to classify embankment material.
D. Set up a seepage monitoring program. Recommended frequency for seepage monitoring is weekly readings at a minimum with water in the reservoir and opportunity readings during outlet gate operation, corresponding reservoir levels and releases through the outlet, if any. Examine seepage along downstream dam slope, determine if seepage is along outlet conduit or broadly spread out across the embankment structure, or both, and examine the existing toe-drain system. Collect discharge measurements with a bucket and stopwatch where possible from point and/or concentrated seepage locations. Perform dye-tracer tests as needed to aid in determining seepage sources. The existing large riprap along the downstream dam slope may need to be temporarily removed in order to visually see and study the seepage to determine extent of seepage. Consultant shall be responsible for coordinating and scheduling the temporary relocation of the riprap for the seepage evaluation and for placing the riprap back on the downstream slope once the seepage evaluation is complete.
E. The City will camera (CCTV) inspect the 30" I.D. steel outlet pipe. With water present in the reservoir, video inspection of the dual 20" steel pipes will not be possible. Video footage will be provided to the consultant.
F. City begins draining Hogchute Reservoir at completion of geotechnical, piezometer installation and seepage investigation. Expected to take 6-weeks to drain reservoir. Reservoir expected to be empty by the end of August depending on consultant's schedule.

- **Task 3 – Outlet Configuration and Condition Assessment:**

A. Perform these tasks with the reservoir empty (September/October).
B. Perform investigations on the existing outlet works to determine the overall physical condition of the piping, gate valves, air vent piping, and the valves hydraulic piping; and determine if seepage is traveling along the path of the outlet works.
C. With the reservoir drained, the City will camera (CCTV) inspect the dual 20" steel outlet pipes. Video footage will be provided to the consultant.
D. Perform pressure testing on the existing steel outlet pipes to determine if the welded steel pipe is able to hold pressure or if pressure is lost due to potential pipe corrosion and/or cracked welds.

E. Evaluate the functionality of the existing outlet works to include pipes, valves, air vents, hydraulic operating system, and trash-rack.
F. Evaluate the option of changing the configuration of the outlet piping on the upstream side of the dam. The City would like for the consultant to investigate the possibility of removing the two 20" gate valves and the dual 20" piping, and replacing this configuration with one 30" I.D. steel pipe and installing a new 30" diameter manually operated outlet valve with a new trash-rack assembly.

- Task 4 – Present Dam Safety Rehabilitation Evaluation:

A. Prepare a detailed report summarizing the findings of the dam safety evaluation and which PFM's need to be addressed and the methods for addressing the PFM's. The results of this dam safety evaluation will serve as the basis for scoping dam rehabilitation work.
B. Present findings of the reservoir's outlet works and the improvements that can be made to maintain a safe and effective outlet works assembly.
C. Provide budgetary cost estimates for the rehabilitation and repair of each PFM that will help the City with planning capital costs.
D. Meet with the City of Grand Junction and the Colo. Dam Safety Office to present and discuss the PFM's that were determined to need rehabilitation and/or repair. Also, provide the consequences of not addressing the PFM's.

- Work Specifically Not Included in this Scope:
  A. Final design of the necessary rehabilitation items and preparation of construction documents and specifications.
  B. On-call bidding and construction support.

4.4. Site Visit/Briefing: A site visit is not scheduled for this Request for Proposal due to the access road being closed because of snow.

4.5. RFP Tentative Time Schedule:

• Request for Proposal available:	April 13, 2018
• Inquiry deadline, no questions after this date:	April 23, 2018
• Addendum Posted:	April 27, 2018
• Submittal deadline for proposals:	May 4, 2018
• Owner evaluation of proposals:	May 7-11, 2018
• Final selection:	May 14, 2018
• Contract execution:	May 15, 2018
• Work begins no later than:	June 11, 2018

4.6. Questions Regarding Scope of Services: All questions regarding this Request for Proposal shall be directed by email to Duane Hoff. All inquiries shall clearly identify the name of the firm and the authorized representative, the RFP number and Title, and all questions to which the responses shall be made.

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 Purchasing Division. 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.rockymountainbidsystem.com. Offerors shall acknowledge receipt of all addenda in their proposal.

Duane Hoff Jr., Senior Buyer
duaneh@gjcity.org

SECTION 5.0: PREPARATION AND SUBMITTAL OF PROPOSALS

Submission: ***Each proposal shall be submitted in electronic format only, and only through the Rocky Mountain E-Purchasing website (https://www.rockymountainbidsystem.com/default.asp).*** *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/BidOpenings.aspx 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**). For proper comparison and evaluation, the City requests that proposals be formatted as directed in Section 5.0 "Preparation and Submittal of Proposals." 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 Owner 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 Owner'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 Contractor agrees to all requirements herein.

B. **Qualifications/Experience/Credentials:** Proposers shall provide their qualifications for consideration as a contract provider to the City of Grand Junction/Mesa County and include prior experience in similar projects.

C. **Strategy and Implementation Plan:** 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** with name, address, telephone number, and email address that can attest to your experience in projects of similar scope and size.

E. **Fee Proposal:** Provide a "not to exceed price" using Solicitation Response Form found in Section 7, **accompanied by a complete list of costs breakdown.**

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 (in no particular order of priority):

- Responsiveness of submittal to the RFP
- Understanding of the project and the objectives
- Experience/Required Skills
- Necessary resources
- Strategy & Implementation Plan
- References
- Fees

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

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 may invite the most qualified rated proposers to participate in oral interviews.

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 Contractor.

SECTION 7.0: SOLICITATION RESPONSE FORM

RFP-4519-18-DH Professional Services for Safety Evaluation of Hogchute Dam

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

1) Not to exceed price to provide all labor, parts, supplies, equipment, travel, etc. necessary for the Forensic Evaluation of Hogchute Dam per specifications:

NOT TO EXCEED PRICE $_____

WRITTEN:_____dollars.

The Owner reserves the right to accept any portion of the work to be performed at its discretion

---

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.

RECEIPT OF ADDENDA: the undersigned Contractor 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

VICINITY MAP
Hogchute Reservoir

Hogchute Reservoir (aka Carson Lake) – Vicinity Map

CITY OF Grand Junction COLORADO
GEOGRAPHIC INFORMATION SYSTEM

SINK CREEK
Cliff Lake
Wilson Blvd
A Rd
BRANDON DITCH
Whitewater Creek Rd
LAURENTNORTH FORK DITCH
KANNAH CREEK
BOWER DITCH
Lands End Rd
44 1/2 Rd
Somerville Res
B. A. & J. DITCH
B. A. & J. DITCH
B. A. & J. DITCH
Anderson Res #6
Bolen Anderson Jacobs #2
Fr 105
Anderson Res #2
Anderson Res #1
Hollenbeck Res 2 - Raber Click
Grand Mesa Res #1
Deep Creek Res #2
Bs-50 5/10 Rd
Lands End Rd
Carson Lake
65
Fs Rd
60 Rd
Crane Lake
As-52 4/10 Rd
Flowing Park Res
Juniata Res
Hallenbeck Res - Purdy Mesa
Reeder Mesa Rd
Purdy Mesa Rd
Kannah Creek Rd
KANNAH CREEK
Blue Sage Dr
Divide Rd
Blair Rd
Grand Mesa View Dr
Purple Sage Ct
Whiting Rd
To Grand Junction
To Delta
50
Red Tail Ct
Bean Ranch Rd
Blue Lake
Chambers Res

1 inch = 5,306 feet
Wednesday, February 28, 2018

INSPECTION REPORT
Division 4 Dam Safety Engineer's Inspection Report
(October 27, 2017)

COLORADO
Division of Water Resources
Department of Natural Resources

Dam Safety Branch

October 27, 2017

Mr. Lee Cooper
City of Grand Junction
250 N. 5th Street
Grand Junction, Colorado 81501
leec@ci.grandjct.co.us

via EMAIL

When replying, please refer to:
HOGCHUTE DAM, DAMID 420127
Water Division 4, Water District 42

Dear Mr. Cooper:

On October 23, 2017, I completed the dam safety inspection for the above referenced structure in accordance with Section 37-87-107 of the Colorado Revised Statutes (C.R.S.), which assigns the State Engineer the responsibility for determining the safe storage level for all reservoirs in Colorado. The enclosed inspection report summarizes my observations during the inspection and identifies actions required to improve the condition and safety and to extend the useful life of the dam. Please review the enclosed report and implement the recommendations listed under "Items Requiring Action by Owner to Improve the Safety of the Dam" on the last page. **Please sign, date, and return a copy of the signature page of the report to this office.**

The dam appears to be in acceptable overall condition at this time. I did not observe any indications of structural dam safety concerns during the inspection. However, I did observe that the seepage appears to be increasing, the spillway crest continues to deteriorate, and the leaking outlet air vents are also deteriorating. None of these issues constitutes a serious cause of concern at this time, but when taken together, they indicate that the dam is in need of some significant remedial work to prevent the development of one or more serious problems. Please refer to the inspection report for more comprehensive discussions of the separate issues.

I understand that the City intends to solicit proposals next year to begin the engineering design for rehabilitating the dam. I strongly encourage the City to include your selected engineering consultant in a comprehensive Dam Safety Evaluation with the Dam Safety Branch

to make certain that all the potential issues are properly considered, so an appropriate scope of work can be developed.

Thank you for your assistance during the inspection. We appreciate your diligent efforts to maintain your dams in a safe condition.
Please call if you have any questions.

Sincerely,

Garrett Jackson, P.E.
Dam Safety Engineer

ec: Dam Safety Branch file
Jason Fuller, District 42 Water Commissioner
Daris M. Matos-Justiniano, P.E., USFS, dmatos@fs.fed.us
Jon Hare, USFS, jhare@fs.fed.us
Trent Prall, City of Grand Junction, trentonp@gjcity.org

ENGINEER'S INSPECTION REPORT

INSPECTOR: GOJ

OFFICE OF THE STATE ENGINEER - DIVISION OF WATER RESOURCES - DAM SAFETY BRANCH 1313 SHERMAN STREET, ROOM 818, DENVER, CO 80203, (303) 866-3581

DAM NAME:	HOGCHUTE	**T:** 120S	**R:** 0960W	**S:** 22	**COUNTY:**	MESA		**DATE OF INSPECTION:**	10/23/2017
DAM ID:	**420127**	**YRCompl:** 1947		**DAM HEIGHT(FT):**	53.0	**SPILLWAY WIDTH(FT):**	140.0	**PREVIOUS INSPECTION:**	8/19/2016
CLASS:	High hazard			**DAM LENGTH(FT):**	620.0	**SPILLWAY CAPACITY(CFS):**	2400.0	**NORMAL STORAGE (AF):**	637.0
DIV:	4	**WD:** 42		**CRESTWIDTH(FT):**	18.0	**FREEBOARD (FT):**	7.0	**SURFACE AREA(AC):**	35.0
EAP:	1/31/2015			**CRESTELEV(FT):**	9890.0	**DRAINAGE AREA (AC.):**	6240.0	**OUTLET INSPECTED:**	9/11/2008

CURRENT RESTRICTION: **-- NONE --**

OWNER:	CITY OF GRAND JUNCTION	**OWNER REP.:**	LEE COOPER
ADDRESS:	250 N. 5TH STREET	**CONTACT NAME:**	LEE COOPER
	GRAND JUNCTION CO 81501-0000	**CONTACT PHONE:**	(970) 256-4155X

INSPECTION PARTY :	Lee Cooper, Slade Connell	Matt Jones	Garrett Jackson
REPRESENTING :	owner	owner	DWR

FIELD CONDITIONS OBSERVED

WATER LEVEL: BELOW DAM CREST _____ FT. Below Spillway ~ 9 FT. GAGE ROD READING ~ 37.1

GROUND MOISTURE CONDITION: ☑ DRY ☐ WET ☐ SNOWCOVER OTHER _____

DIRECTIONS: MARK AN X FOR CONDITIONS FOUND AND UNDERLINE WORDS THAT APPLY

UPSTREAM SLOPE

PROBLEMS NOTED ☐ (0)NONE ☑ (1)RIPRAP - MISSING, SPARSE, DISPLACED, WEATHERED ☑ (2) WAVE EROSION - WITH SCARPS

☐ (3) CRACKS WITH DISPLACEMENT ☐ (4) SINKHOLE ☐ (5) APPEARS TOO STEEP ☐ (6) DEPRESSIONS OR BULGES ☐ (7) SLIDES

☐ (8) CONCRETE FACING - HOLES, CRACKS, DISPLACED, UNDERMINED ☑ (9) OTHER some beaching

Reservoir level has been lowered to about 9' below the spillway, permitting observation of a part of the slope that has not been seen in many years.
Slope is generally even and uniform, with no bulges or slumps observed.
(1) Riprap is generally large rock with some displacement both above and below the NWL. The silty clay embankment is exposed in some small areas between the rocks, but no erosion of the slope is evident.
(2, 9) Wave action at the NWL has caused some minor riprap displacement and beaching, but no erosion or scarping of the slope.

CONDITIONS OBSERVED: ☐ Good ☒ Acceptable ☐ Poor

CREST

PROBLEMS NOTED ☑ (10) NONE ☐ (11 RUTS OR PUDDLES ☐ (12) EROSION ☐ (13) CRACKS - WITH DISPLACEMENT ☐ (14) SINKHOLES

☐ (15) NOT WIDE ENOUGH ☐ (16) LOW AREA ☐ (17) MISALIGNMENT ☐ (18) IMPROPER SURFACE DRAINAGE ☐ (19) OTHER

No significant change since previous inspection.

CONDITIONS OBSERVED: ☐ Good ☒ Acceptable ☐ Poor

DOWNSTREAM SLOPE

PROBLEMS NOTED ☐ (20) NONE ☐ (21) LIVESTOCK DAMAGE ☐ (22) EROSION OR GULLIES ☐ (23) CRACKS - WITH DISPLACEMENT ☐ (24) SINKHOLE

☐ (25) APPEARS TOO STEEP ☑ (26) DEPRESSIONS OR BULGES ☐ (27) SLIDE ☐ (28) SOFT AREAS ☑ (29) OTHER

Generally uniform, uneven slope covered with small to large rock. No indications of recent or current slope movements.
(29) 1947 construction plans for the original dam show a flattened "bench" area ~ 1/4 of the way up the slope above the outlet basin. This bench is not evident now, nor is it evident in photos as early as 1975; however, there is a minor grade break at about this elevation in the present slope.

CONDITIONS OBSERVED: ☐ Good ☒ Acceptable ☐ Poor

ENGINEER'S INSPECTION REPORT DATE. 10/23/2017

DAM NAME: HOGCHUTE DAM I.D.: 420127

SEEPAGE

PROBLEMS NOTED ☐ (30) NONE ☐ (31) SATURATED EMBANKMENT AREA ☐ (32) SEEPAGE EXITS ON EMBANKMENT

☐ (33) SEEPAGE EXITS AT POINT SOURCE ☑ (34) SEEPAGE AREA AT TOE ☐ (35) FLOW ADJACENT TO OUTLET ☑ (36) SEEPAGE INCREASED / MUDDY

DRAIN OUTFALLS SEEN ☐ No ☑ Yes Show location of drains on sketch and indicate amount and quality of discharge. ☐ (37) FLOW INCREASED / MUDDY ☐ (38) DRAIN DRY / OBSTRUCTED

☑ (39) OTHER bank seepage

No significant change in embankment seepage since previous inspections.
The only "drain outfalls" present on this dam are the PVC pipe submerged in the outlet discharge basin and the small PVC pipe draining the area behind the outlet headwall where seepage ponds in the rocks. The pipe submerged in the outlet basin is likely the outfall from the 8" tile toe drain shown on the 1947 plans.
(36, 39) Two small seepage channels flow from the willows on the right bank of the outlet channel and discharge to the outlet channel immediately below the dam. Total seepage in these small channels is only a few gpm, but the channels are becoming more established and evident, indicating the seepage is greater and/or more persistent than in past years.

"Poor" rating reflects concern that the toe drain seepage cannot be monitored, and the minor hillside seepage above the outlet channel appears to be increasing.

CONDITIONS OBSERVED: ☐ Good ☐ Acceptable ☒ Poor

OUTLET

PROBLEMS NOTED ☐ (40) NONE ☐ (41) NO OUTLET FOUND ☐ (42) POOR OPERATING ACCESS ☐ (43) INOPERABLE

☑ (44) UPSTREAM OR DOWNSTREAM STRUCTURE DETERIORATED (45) OUTLET OPERATED DURING INSPECTION ☐ YES ☑ NO

INTERIOR INSPECTED ☑ (120) NO ☐ (121)YES ☐ (46) CONDUIT DETERIORATED OR COLLAPSED ☐ (47) JOINTS DISPLACED ☑ (48) VALVE LEAKAGE

☐ (49) OTHER

Outlet gates operate cleanly, are exercised regularly.
(44, 48) Constant discharge from the outlet conduit is from breaks in the air vents behind the outlet gates. Discharge has increased over the years and is now about 2.6 cfs. For the air vent, which is buried in the upstream slope, to pass this much water, the vent pipe is either directly open to the reservoir, or the leak occurs at the underwater headwall structure. 2008 video of the outlet conduit shows some rusted spots and areas where past rust has been ground out and coated. Recent rusty areas were reportedly repaired in a similar manner after the inspection. The video indicates that the air vents on both gates are passing water. The conduit will be due for another video inspection next year (2018).

1947 plans show a gate control structure at the downstream toe, with hydraulic gate control lines running within the conduit's concrete encasement to the upstream gates. A single 4" air vent buried in the upstream slope bifurcates into two 2" lines to vent the two gates. In 1988, the control structure was moved to the dam crest, and new hydraulic lines were run to the gates, but the SEO is not aware of any construction plans for this work.

Combined "Acceptable" and "Poor" rating indicates that the outlet gates appear to function adequately, and the outlet conduit is in overall good condition. However, the location and nature of the air vent leak is unknown, and the leakage is increasing. There are no records for the 1988 construction of the gate control lines. The potential impacts of the 1988 construction to the integrity and stability of the slope are unknown and should be investigated.

CONDITIONS OBSERVED: ☐ Good ☒ Acceptable ☒ Poor

SPILLWAY

PROBLEMS NOTED ☐ (50) NONE ☐ (51) NO EMERGENCY SPILLWAY FOUND ☐ (52) EROSION WITH BACKCUTTING ☑ (53) CRACK - WITH DISPLACEMENT

☐ (54) APPEARS TO BE STRUCTURALLY INADEQUATE ☐ (55) APPEARS TOO SMALL ☐ (56) INADEQUATE FREEBOARD ☐ (57) FLOW OBSTRUCTED

☑ (58) CONCRETE DETERIORATED / UNDERMINED ☑ (59) OTHER

Open channel on rock and soil at right end of dam. Flat approach and exit channels tend to become clogged with vegetation and brush. Noticeably uneven water line on the concrete indicates the crest structure is not level.
(53, 58) Concrete crest structure is badly deteriorated and cracked through in several places, permitting water to flow under the crest.
(59) 1947 construction plans show a 20'-wide (10' bottom width) trapezoidal low-flow channel through the center of the spillway. This channel does not exist now.

Combined "Acceptable" and "Poor" rating is based on observed acceptable performance of the existing spillway, coupled with concerns that the spillway capacity has been reduced by filling in the low-flow channel. The dam was recently reclassified as a High Hazard structure, and the spillway should be evaluated to verify it has the required capacity for passing the IDF associated with the revised hazard classification.

CONDITIONS OBSERVED: ☐ Good ☒ Acceptable ☒ Poor

ENGINEER'S INSPECTION REPORT
DAM NAME: HOGCHUTE

DATE. 10/23/2017
DAM I.D.: 420127

MONITORING

EXISTING INSTRUMENTATION FOUND ☐ (110) NONE ☑ (111) GAGE ROD ☐ (112) PIEZOMETERS ☐ (113) SEEPAGE WEIRS / FLUMES
☐ (114) SURVEY MONUMENTS ☑ (115) OTHER outlet basin drain outfall and discharge flume

MONITORING OF INSTRUMENTATION ☐ (116) NO ☑ (117) YES PERIODIC INSPECTIONS BY: ☑ (118) OWNER ☐ (119) ENGINEER

Owner observes dam frequently and collects seepage readings from the outlet headwall drain. However, no monitoring evaluation reports are submitted to the SEO.

"Poor" rating reflects concern that the monitoring data are not evaluated and reported. Diligent monitoring, evaluation, and reporting of the data are required for the continued full operation of this High Hazard dam.

CONDITIONS OBSERVED: ☐ Good ☐ Acceptable ☒ Poor

MAINTENANCE AND REPAIRS

PROBLEMS NOTED ☐ (60 NONE ☐ (61) ACCESS ROAD NEEDS MAINTENANCE ☐ (62) LIVESTOCK DAMAGE
☑ (63) BRUSH ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE ☐ (64) TREES ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE
☐ (65) RODENT ACTIVITY ON UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, TOE ☑ (66) DETERIORATED CONCRETE - FACING, OUTLET SPILLWAY
☑ (67) GATE AND OPERATING MECHANISM NEED MAINTENANCE ☐ (68) OTHER

Dam is generally well maintained. Brush has been sprayed and largely controlled on the dam crest and slopes.
(63) Brush tends to grow in the spillway approach and exit channels.
(66) Concrete spillway crest is badly deteriorated, not level.
(67) Outlet gate air vents leakage is increasing.

Combined "Acceptable" and "Poor" rating indicates that routine maintenance is quite good, but some conditions are deteriorating and must be addressed to prevent the development of dam safety issues.

CONDITIONS OBSERVED: | | Good | X | Acceptable | X | Poor

Go to next page for Overall Conditions and Items Requiring Actions

ENGINEER'S INSPECTION REPORT DATE. 10/23/2017

DAM NAME: HOGCHUTE DAM I.D.: 420127

OVERALL CONDITIONS

The embankment appears to be in overall acceptable condition at this time. However, as discussed in the respective sections of this report, there are potentially serious concerns with the performance of the outlet works, with the condition and discharge capacity of the spillway, and with the seepage conditions. The dam is currently rated as "Conditionally Satisfactory", which means the dam can be used for full storage as long as the City complies with the action items noted in the "Actions" section of this report. If conditions should deteriorate at the dam, the rating will be reconsidered, and a storage restriction may be warranted.

As discussed in the Monitoring section of this report, I am aware that the City collects monitoring data at the dam on a regular basis. However, I have received no reports evaluating the data. The monitoring instruments must be monitored, the data must be evaluated by the City's engineer, and a summary report must be sent to this office annually. Only by following the monitoring-evaluating-reporting process can we be reasonably assured that conditions at the dam are not gradually deteriorating, which could lead to a safety problem that would require an emergency response. Please institute the required monitoring and reporting process as soon as possible.

I understand that the City intends to solicit proposals next year for rehabilitating the dam. I strongly encourage the City to include your selected engineering consultant in a Comprehensive Dam Safety Evaluation with the Dam Safety Branch to make certain that all the potential issues are properly considered, and an appropriate scope of work can be developed.

Based on this Safety Inspection and recent file review, the overall condition is determined to be:

☐ (71) SATISFACTORY ☑ (72) CONDITIONALLY SATISFACTORY ☐ (73) UNSATISFACTORY

ITEMS REQUIRING ACTION BY OWNER TO IMPROVE THE SAFETY OF THE DAM

The State Engineer, by providing this dam safety inspection report, does not assume responsibility for any unsafe condition of the subject dam. The sole responsibility for the safety of this dam rests with the reservoir owner or operator, who should take every step necessary to prevent damages caused by leakage or overflow of waters from the reservoir or floods resulting from a failure of the dam.

MAINTENANCE - ORDINARY REPAIR - MONITORING

☐ (80) PROVIDE ADDITIONAL RIPRAP:

☑ (81) LUBRICATE AND OPERATE OUTLET GATES THROUGH FULL CYCLE **at least yearly**

☑ (82) CLEAR TREES AND/OR BRUSH FROM: **spillway**

☐ (83) INITIATE RODENT CONTROL PROGRAM AND PROPERLY BACKFILL EXISTING HOLES:

☐ (84) GRADE CREST TO A UNIFORM ELEVATION WITH DRAINAGE TO THE UPSTREAM SLOPE:

☐ (85) PROVIDE SURFACE DRAINAGE FOR:

☑ (86) MONITOR: **reservoir level and seepage, including the seepage on the right bank of the outlet channel**

☑ (87) DEVELOP AND SUBMIT AN EMERGENCY ACTION PLAN: **update existing EAP as necessary**

☐ (88) OTHER

☐ (89) OTHER

ENGINEERING - EMPLOY AN ENGINEER EXPERIENCED IN DESIGN AND CONSTRUCTION OF DAMS TO: (Plans and Specifications must be approved by State Engineer prior to construction.

☐ (90) PREPARE PLANS AND SPECIFICATIONS FOR REHABILITATION OF THE DAM:

☐ (91) PREPARE AS -BUILT DRAWINGS OF:

☐ (92) PERFORM A GEOTECHNICAL INVESTIGATION TO EVALUATE THE STABILITY OF THE DAM:

☑ (93) PERFORM A HYDROLOGIC STUDY TO DETERMINE REQUIRED SPILLWAY SIZE: **in conjunction with the planned dam rehabilitation**

☐ (94) PREPARE PLANS AND SPECIFICATIONS FOR AN ADEQUATE SPILLWAY:

☑ (95) SET UP A MONITORING SYSTEM INCLUDING WORK SHEETS, REDUCED DATA AND GRAPHED RESULTS: **evaluate the monitoring data and submit an annual summary report to this office**

☑ (96) PERFORM AN INTERNAL INSPECTION OF THE OUTLET: **by 12/31/2018**

☑ (97) OTHER: **investigate the leaking outlet gate air vents**

☐ (98) OTHER:

☐ (99) OTHER:

SAFE STORAGE LEVEL: RECOMMENDED AS A RESULT OF THIS INSPECTION

☐ (101) FULL STORAGE

☑ (102) CONDITIONAL FULL STORAGE

☐ (103) RECOMMENDED RESTRICTION → { _____ FT. BELOW DAM CREST; _____ FT. BELOW SPILLWAY CREST; _____ FT. GAGE HEIGHT; ☐ NO STORAGE-MAINTAIN OUTLET FULLY OPEN

☐ (104) CONTINUE EXISTING RESTRICTION

REASON FOR RESTRICTION

ACTIONS REQUIRED FOR CONDITIONAL FULL STORAGE OR CONTINUED STORAGE AT THE RESTRICTED LEVEL:

Complete maintenance and engineering items noted above. Please note the deadline for the outlet video inspection (item 96). Other items requiring an engineer can be accomplished in coniunction with your planned dam rehabilitation.

Engineer's Signature _____ INSPECTED BY

Owner's Signature _____ OWNER/OWNER'S REPRESENTATIVE DATE: ___/___/___

ENGINEER'S INSPECTION REPORT
DAM NAME: HOGCHUTE

DATE. 10/23/2017
DAM I.D.: 420127

GUIDELINES FOR DETERMINING CONDITIONS

CONDITIONS OBSERVED - APPLIES TO UPSTREAM SLOPE, CREST, DOWNSTREAM SLOPE, OUTLET, SPILLWAY

GOOD
In general, this part of the structure has a near new appearance, and conditions observed in this area do not appear to threaten the safety of the dam.

ACCEPTABLE
Although general cross-section is maintained, surfaces may be irregular, eroded, rutted, spalled, or otherwise not in new condition. Conditions in this area do not currently appear to threaten the safety of the dam.

POOR
Conditions observed in this area appear to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO SEEPAGE

GOOD
No evidence of uncontrolled seepage. No unexplained increase in flows from designed drains. All seepage is clear. Seepage conditions do not appear to threaten the safety of the dam.

ACCEPTABLE
Some seepage exists at areas other than the drain outfalls, or other designed drains. No unexplained increase in seepage. All seepage is clear. Seepage conditions observed do not currently appear to threaten the safety of the dam.

POOR
Seepage conditions observed appear to threaten the safety of the dam. Examples:
1) Designed drain or seepage flows have increased without increase in reservoir level.
2) Drain or seepage flows contain sediment, i.e., muddy water or particles in jar samples.
3) Widespread seepage, concentrated seepage, or ponding appears to threaten the safety of the dam.

CONDITIONS OBSERVED - APPLIES TO MONITORING

GOOD
Monitoring includes movement surveys and leakage measurements for all dams, and piezometer readings for High hazard dams. Instrumentation is in reliable, working condition. A plan for monitoring the instrumentation and analyzing results by the owner's engineer is in effect. Periodic inspections by owner's engineer.

ACCEPTABLE
Monitoring includes movement surveys and leakage measurements for High and Significant hazard dams; leakage measurements for Low hazard dams. Instrumentation is in serviceable condition. A plan for monitoring instrumentation is in effect by owner. Periodic inspections by owner or representative. OR, NO MONITORING REQUIRED.

POOR
All instrumentation and monitoring described under "ACCEPTABLE" here for each class of dam, are not provided, or required periodic readings are not being made, or unexplained changes in readings are not reacted to by the owner.

CONDITIONS OBSERVED - APPLIES TO MAINTENANCE AND REPAIR

GOOD
Dam appears to receive effective on-going maintenance and repair, and only a few minor items may need to be addressed.

ACCEPTABLE
Dam appears to receive maintenance, but some maintenance items need to be addressed. No major repairs are requirecl

POOR
Dam does not appear to receive adequate maintenance. One or more items needing maintenance or repair has begun to threaten the safety of the dam.

OVERALL CONDITIONS

SATISFACTORY
The safety inspection indicates no conditions that appear to threaten the safety of the dam, and the dam is expected to perform satisfactorily under all design loading conditions. Most of the required monitoring is being performed.

CONDITIONALLY SATISFACTORY
The safety inspection indicates symptoms of structural distress (seepage, evidence of minor displacements, etc.), which, if conditions worsen, could lead to the failure of the dam. Essential monitoring, inspection, and maintenance must be performed as a requirement for continued full storage in the reservoir.

UNSATISFACTORY
The safety inspection indicates definite signs of structural distress (excessive seepage, cracks, slides, sinkholes, severe deterioration, etc.), which could lead to the failure of the dam if the reservoir is used to full capacity. The dam is judged unsafe for full storage of water.

SAFE STORAGE LEVEL

FULL STORAGE
Dam may be used to full capacity with no conditions attached.

CONDITIONAL FULL STORAGE
Dam may be used to full storage if certain monitoring, maintenance, or operational conditions are met.

RESTRICTION
Dam may not be used to full capacity, but must be operated at some reduced level in the interest of public safety.

HAZARD CLASSIFICATION OF DAMS

High hazard
Loss of human life is expected in the event of failure of the dam, while the reservoir is at the high water line.

Significant hazard
Significant damage to improved property is expected in the event of failure of the dam while the reservoir is at the high water line, but no loss of human life is expected.

Low hazard
Loss of human life is not expected, and damage to improved property is expected to be small, in the event of failure of the dam while the reservoir is at high water fine.

NPH hazard - No loss of life or damage to improved property, or loss of downstream resource is expected in the event of failure of the dam while the reservoir is at the high water line.

ENGINEER'S INSPECTION REPORT PHOTOGRAPHS ATTACHMENT

Dam Name: Hogchute
DamID 420127

Date: 10/23/2017

	Upstream slope and crest viewed from spillway at right end of dam.
	Roof and corners of outlet control structure are badly deteriorated, but building is intact and secure.

ENGINEER'S INSPECTION REPORT PHOTOGRAPHS ATTACHMENT

Dam Name: Hogchute
DamID 420127

Date: 10/23/2017

Outlet channel viewed from crest.

Two small but distinct seepage channels flow through the willows on the right and discharge into the outlet channel.

Seepage ponds behind the old retaining wall and drains around the right end.

Seepage drain around the right end of the old retaining wall.

ENGINEER'S INSPECTION REPORT PHOTOGRAPHS ATTACHMENT

Dam Name: Hogchute
DamID 420127

Date: 10/23/2017

	A PVC pipe, believed to be a toe drain discharge pipe, is submerged in the left side of the outlet basin.
	Deterioration of the concrete retaining wall at the outlet discharge.

ENGINEER'S INSPECTION REPORT PHOTOGRAPHS ATTACHMENT

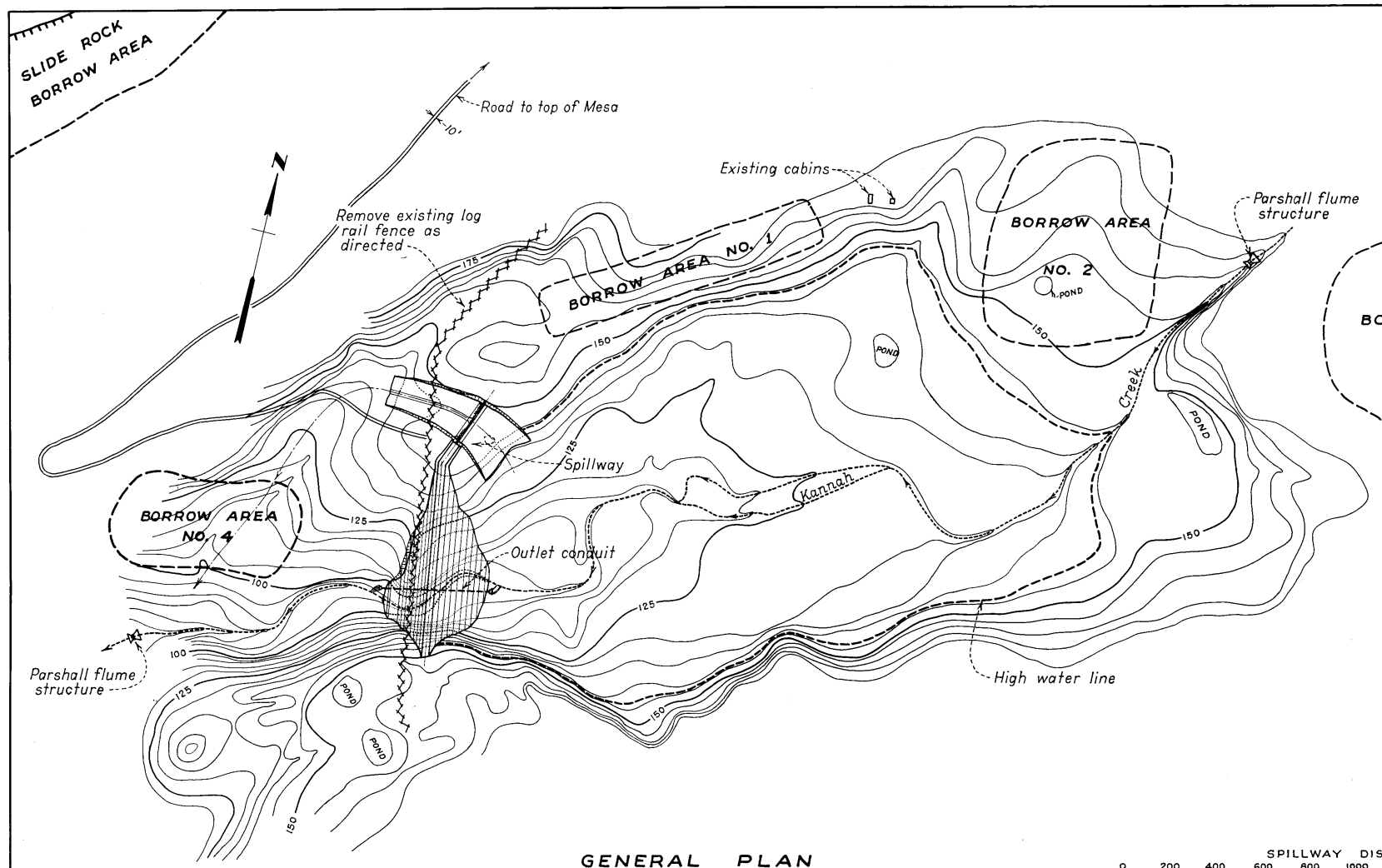
Dam Name: Hogchute
DamID 420127

Date: 10/23/2017

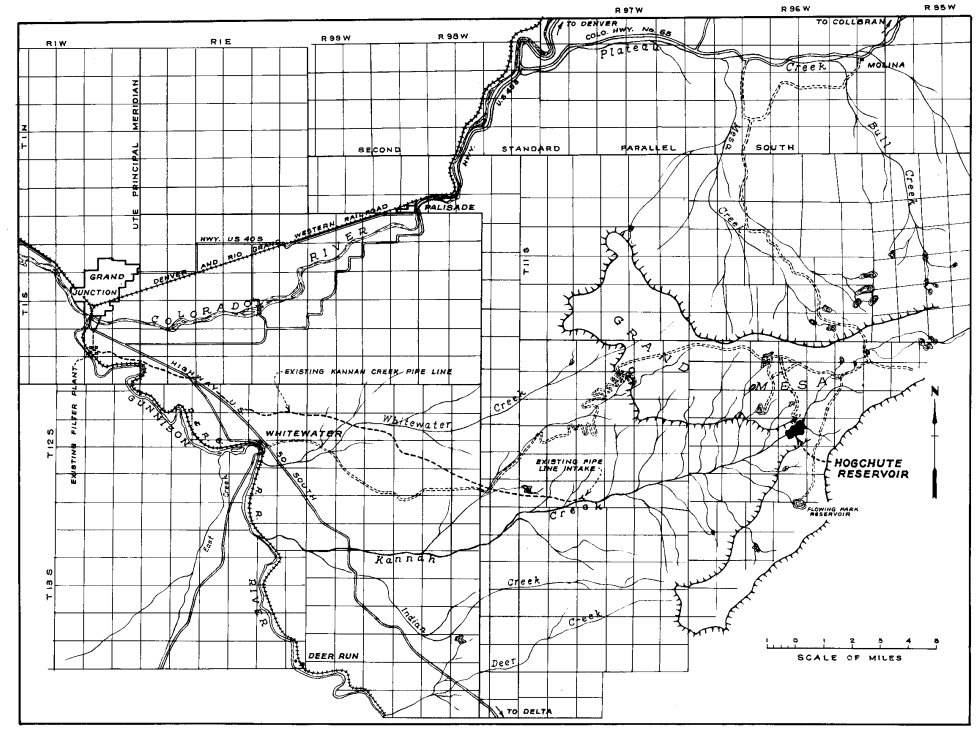
Spillway control structure is deteriorated and cracked through in several places. Note uneven waterline on the concrete.

Apparent concrete overlay on old spillway crest.

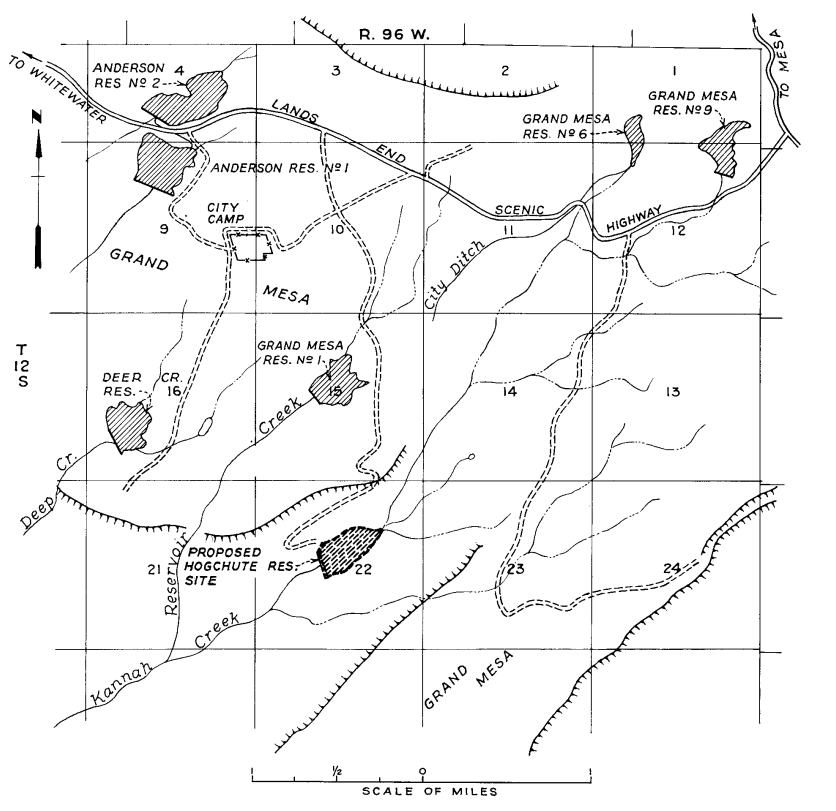
1947 HOGCHUTE CONSTRUCTION PLANS



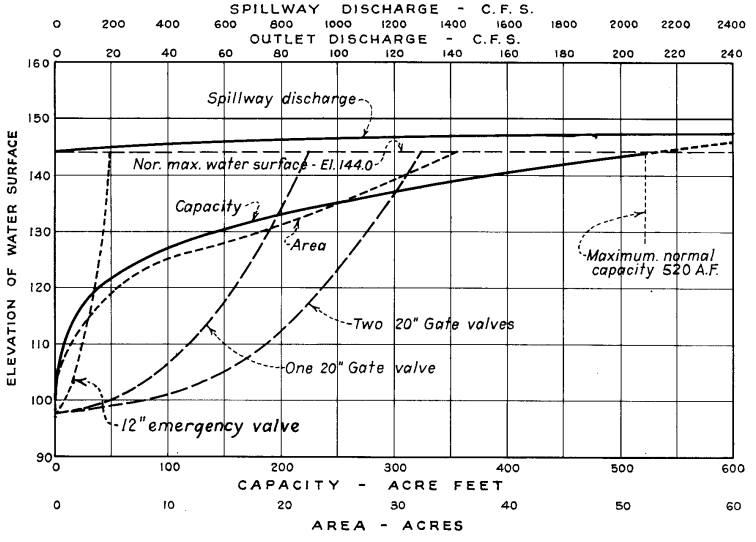
GENERAL PLAN



VICINITY MAP



LOCATION MAP



AREA, CAPACITY AND DISCHARGE CURVES

NOTES

Reservoir site is entirely within the limits of the Grand Mesa National Forest. All clearing operations, cutting and disposal of timber, shall be performed in accordance with rules and regulations prescribed by the Forest Supervisor

Altitude of reservoir site is approximately elevation 9250

REFERENCE DRAWINGS

VICINITY MAP AND GENERAL PLAN	705-30
PLAN, PROFILE AND SECTIONS	705-31
OUTLET WORKS - VALVE CONTROL HOUSE	705-32
TRASHRACK STRUCTURE AND SPILLWAY DETAILS	705-33
PARSHALL FLUME - PLAN, SECTIONS AND DETAILS	705-34

Approved on the 24 day of May 1947

By _____ STATE ENGINEER

By _____ DEPUTY

CITY OF GRAND JUNCTION

R.J. TIPTON AND ASSOCIATES INC., ENGINEERS

DENVER, COLORADO

IMPROVEMENTS TO WATER SUPPLY SYSTEM

HOGCHUTE RESERVOIR

VICINITY MAP AND GENERAL PLAN

DRAWN N.L.L. APPROVED _____ DIRECTOR OF PUBLIC WORKS AND PLANNING

TRACED L.W.M. APPROVED _____

CHECKED N.L.L. APPROVED _____ CITY MANAGER

DENVER, COLORADO MAY 1947 705-30

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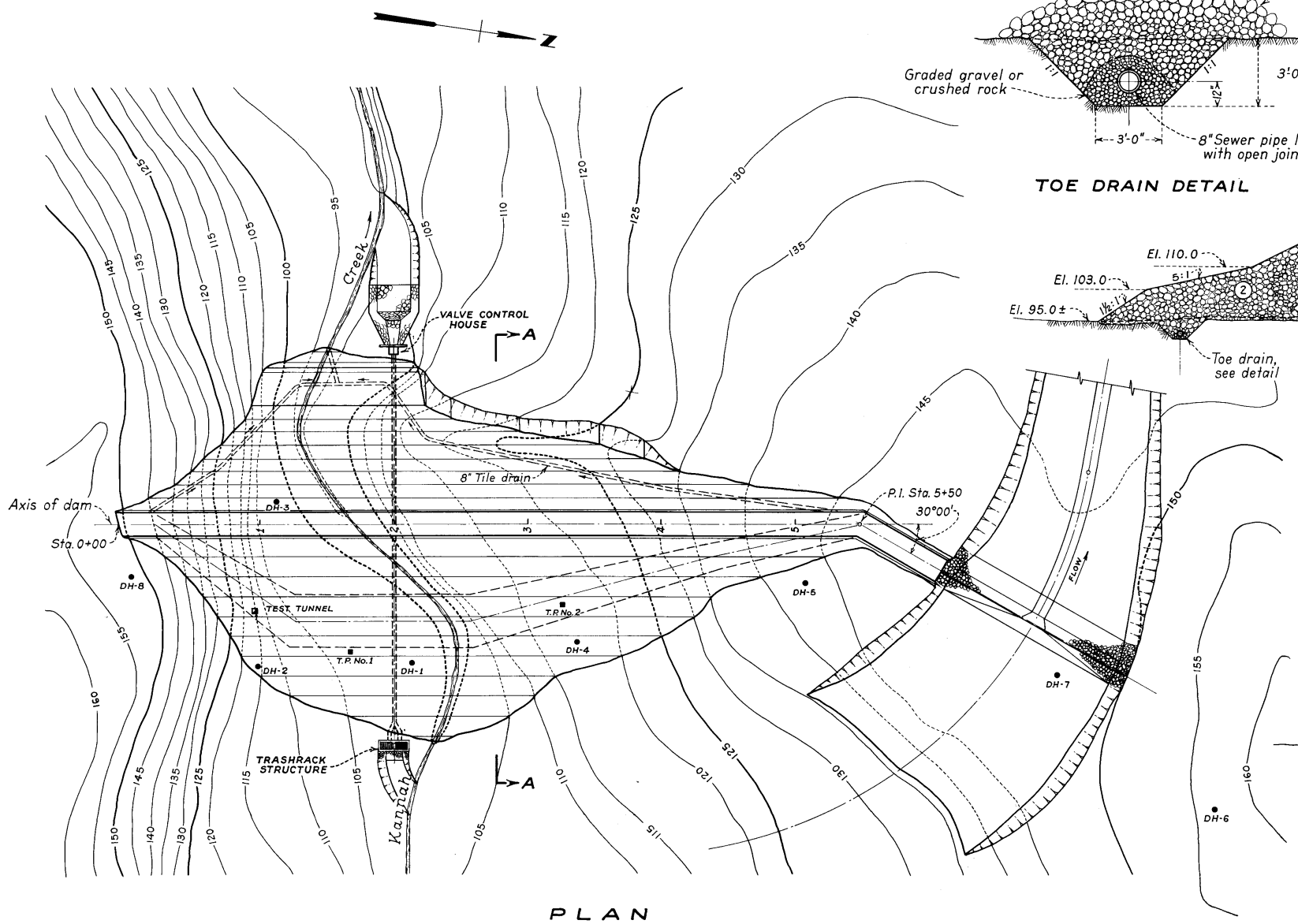
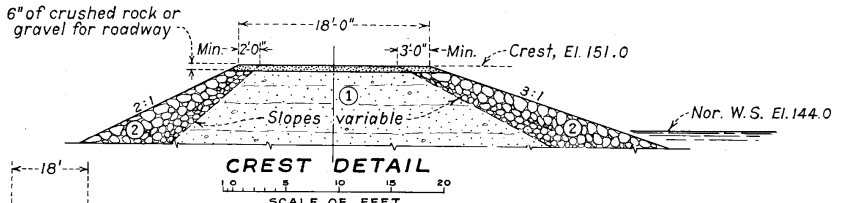
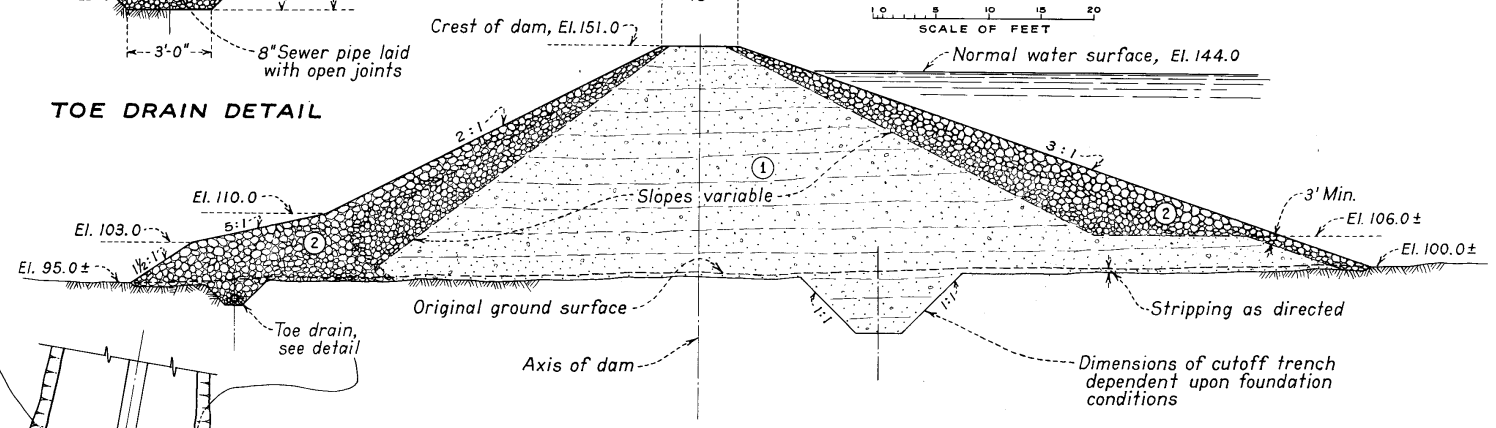


PLAN

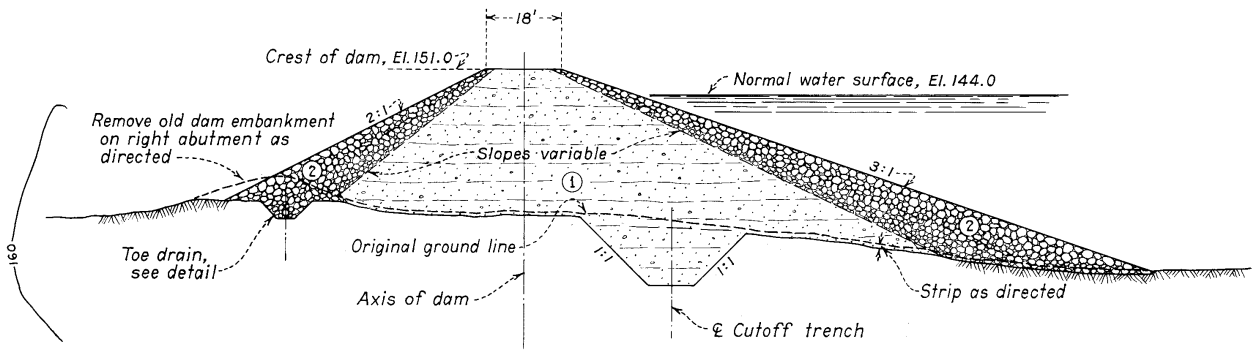
TOE DRAIN DETAIL



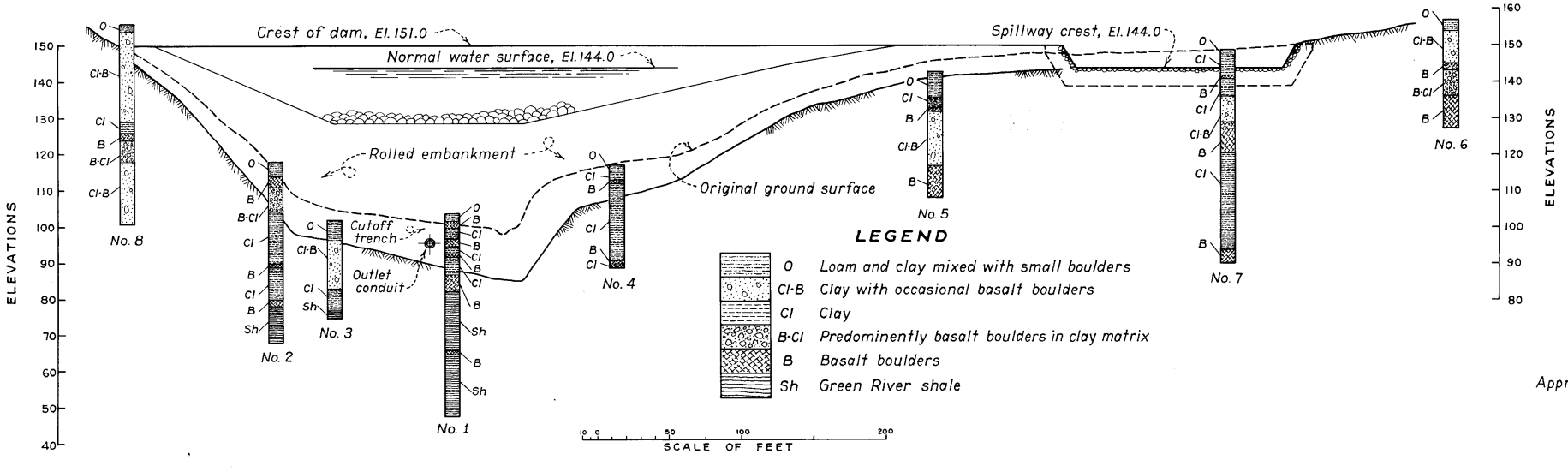


MAXIMUM SECTION

10 0 20 40 60 80 100
SCALE OF FEET



SECTION A-A



PROFILE ON ℄ OF CUTOFF TRENCH AND SPILLWAY - LOG OF DRILL HOLES

LEGEND

O	Loam and clay mixed with small boulders
Cl-B	Clay with occasional basalt boulders
Cl	Clay
B-Cl	Predominently basalt boulders in clay matrix
B	Basalt boulders
Sh	Green River shale

EMBANKMENT NOTES

① Impervious fill of clay or clay, sand and gravel graded with coarser material on outer slopes and compacted in 6" layers.
② Cobble and rock fill graded with coarser material on outer slopes.

NOTES

All elevations refer to an assumed datum
Final location of outlet works and appurtenant structures are dependent on foundation conditions encountered.

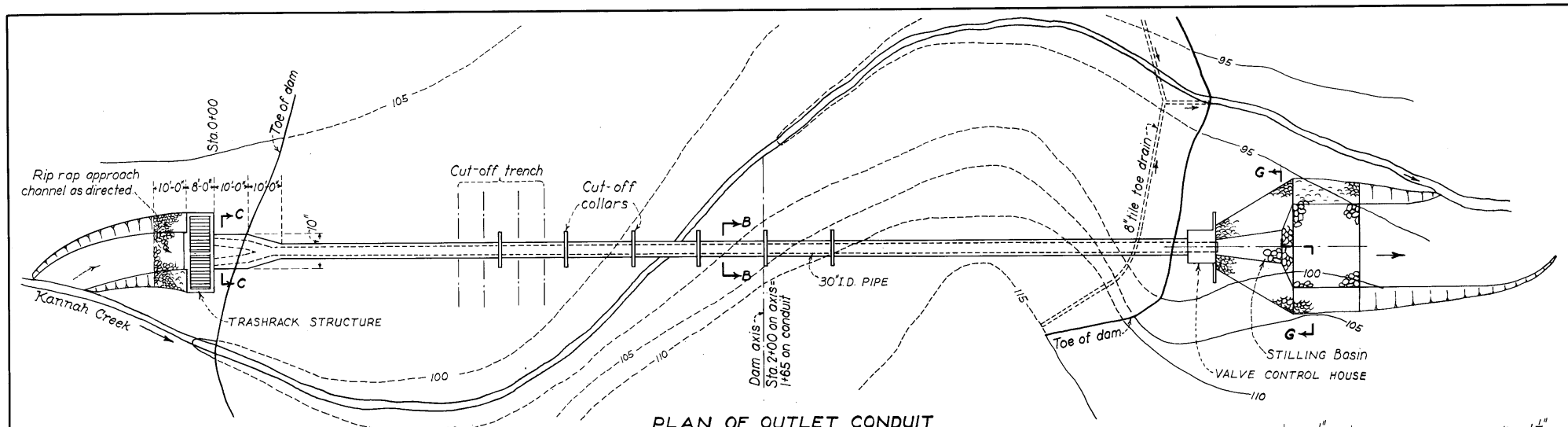
Approved on the 24 day of May 1947
By M. C. Hinderlider
STATE ENGINEER
By
DEPUTY

CITY OF GRAND JUNCTION
R.J. TIPTON AND ASSOCIATES INC., ENGINEERS
DENVER, COLORADO

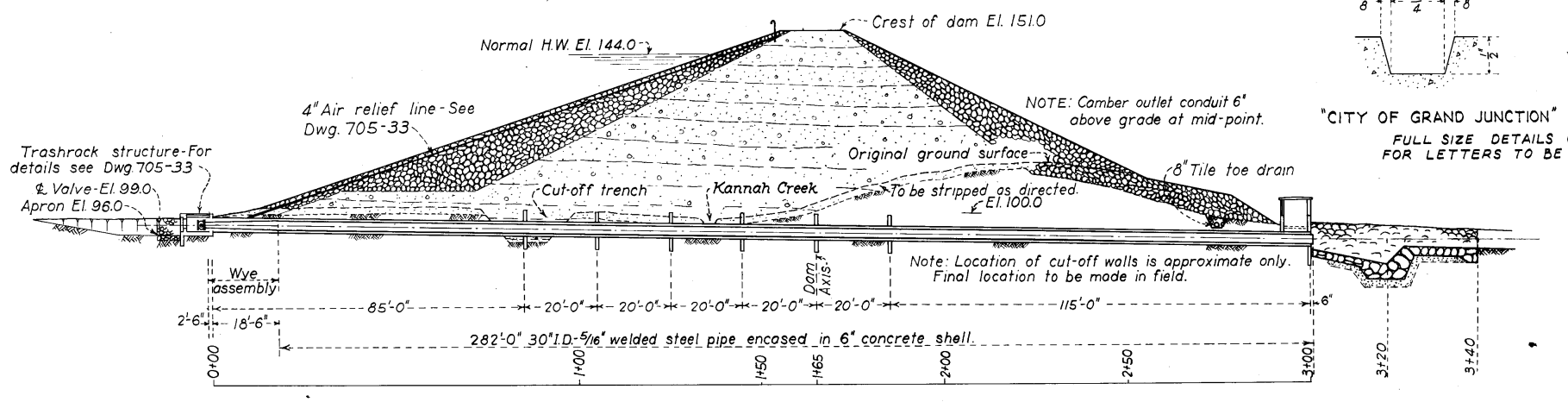
IMPROVEMENTS TO WATER SUPPLY SYSTEM
HOGCHUTE RESERVOIR
PLAN, PROFILE AND SECTIONS

DRAWN N.L.L.	APPROVED R.J. TIPTON AND ASSOCIATES, INC.		
TRACED L.W.M.	APPROVED DIRECTOR OF PUBLIC WORKS AND PLANNING		
CHECKED N.L.L.	APPROVED CITY MANAGER		
	DENVER, COLORADO MAY 1947	705-31	

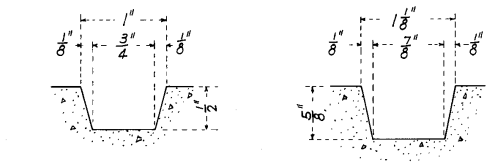
C-454



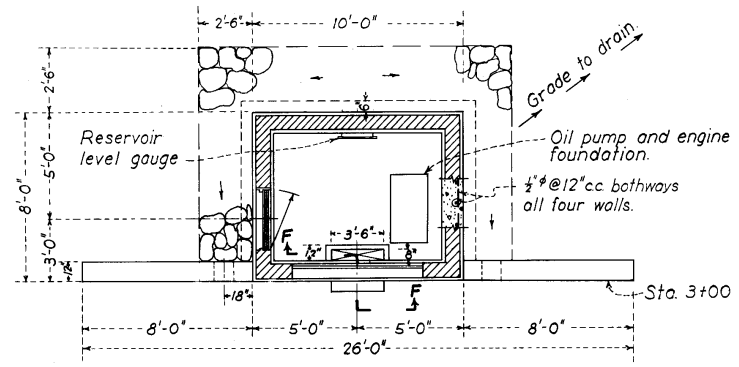
PLAN OF OUTLET CONDUIT



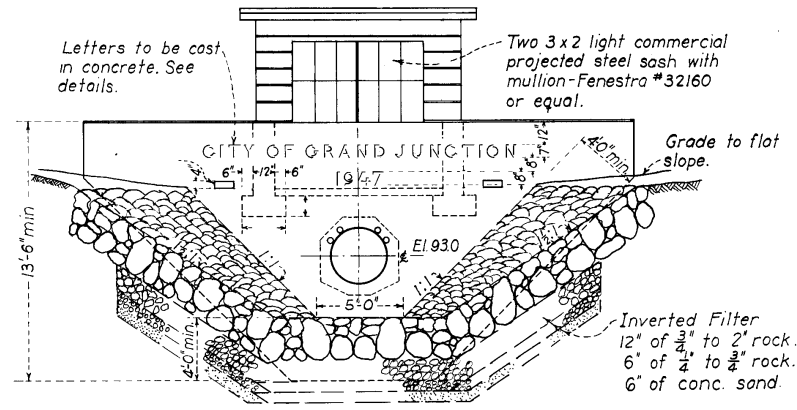
SECTION ALONG ℄ OF OUTLET CONDUIT



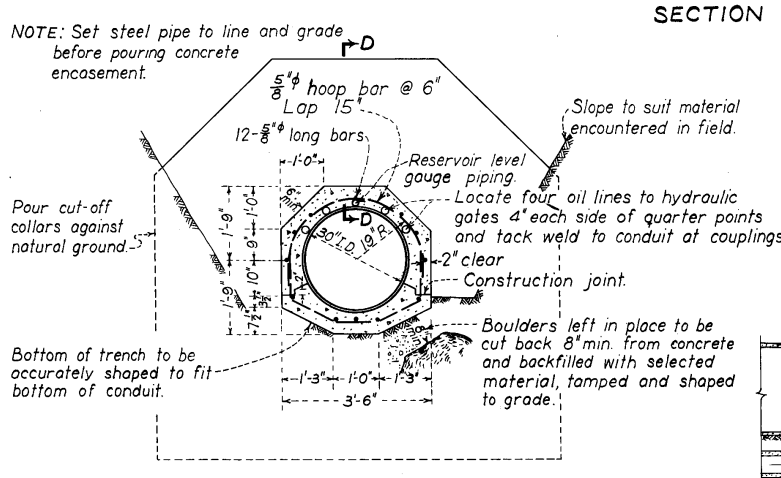
FULL SIZE DETAILS OF RECESSES FOR LETTERS TO BE CAST IN CONCRETE



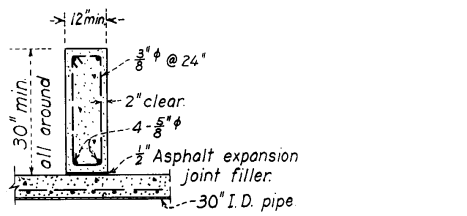
PLAN



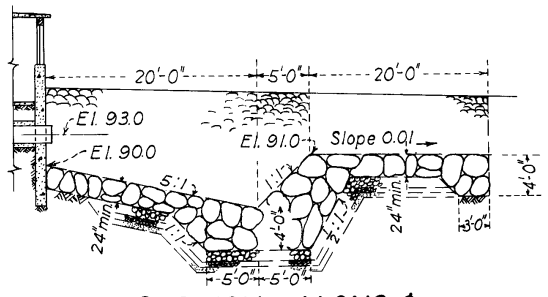
FRONT ELEVATION



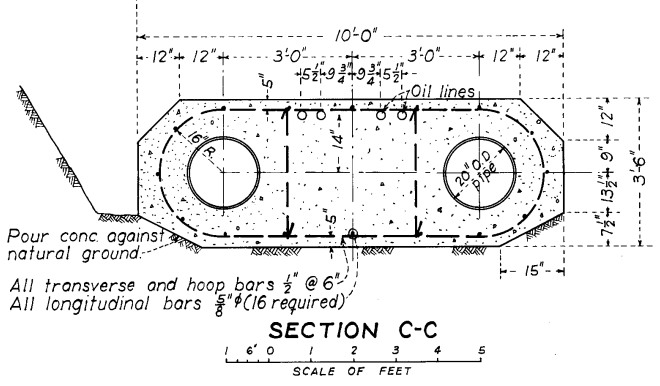
(TYPICAL SECTION)
SECTION B-B



SECTION D-D

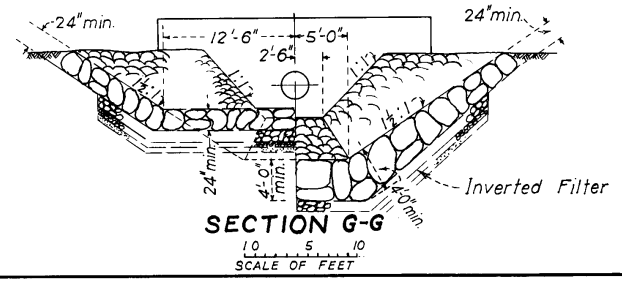


SECTION ALONG ℄



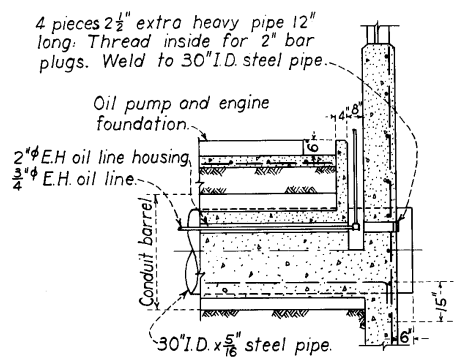
SECTION C-C

1 6" 0 1 2 3 4 5
SCALE OF FEET

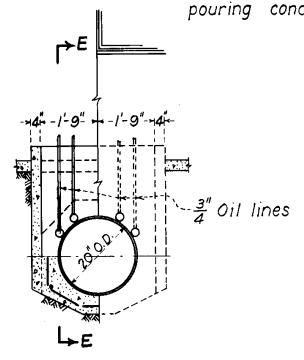


SECTION G-G

10 5 10
SCALE OF FEET



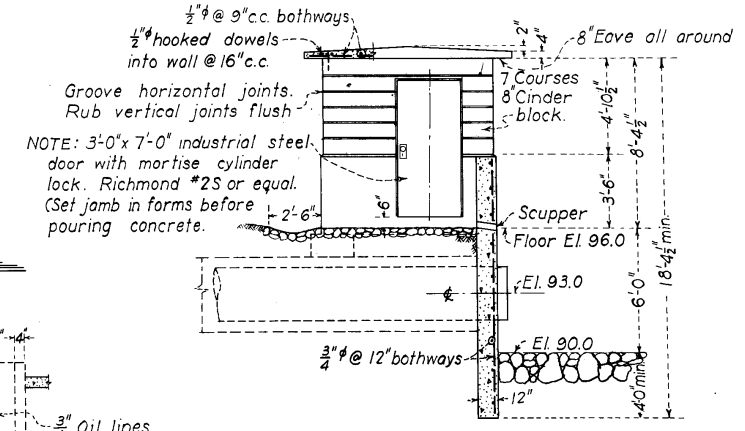
SECTION E-E



SECTION F-F

PIPE WELL DETAILS

1 0 1 2 3 4 5
SCALE OF FEET



SIDE ELEVATION
VALVE CONTROL HOUSE

1 0 1 2 3 4 5 6 7
SCALE OF FEET

Approved on the 24 day of May 1947

By M. C. Hinderlider
STATE ENGINEER

By .....
DEPUTY

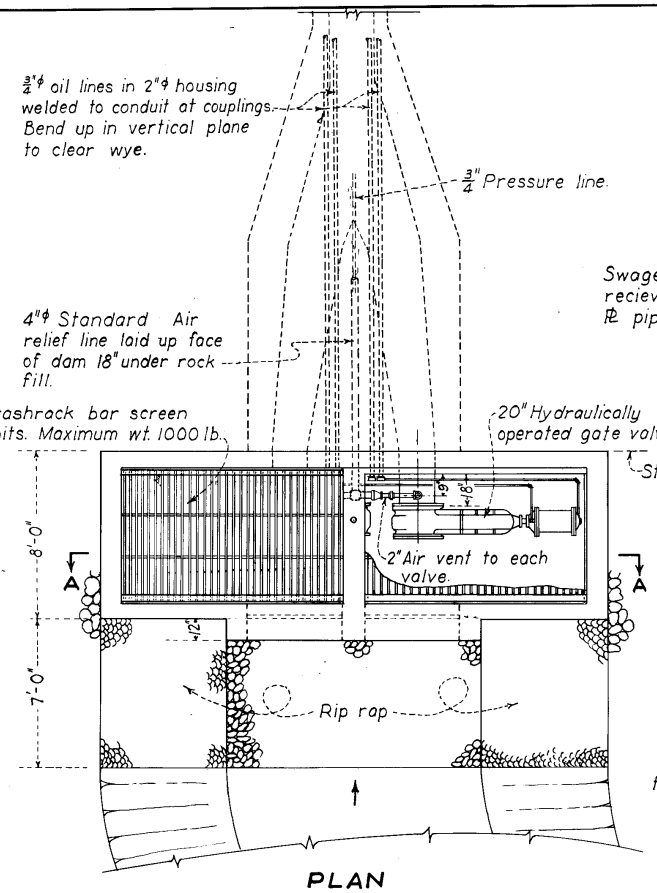
CITY OF GRAND JUNCTION
R. J. TIPTON AND ASSOCIATES INC., ENGINEERS
DENVER, COLORADO

IMPROVEMENTS TO WATER SUPPLY SYSTEM
HOGCHUTE RESERVOIR
OUTLET WORKS
VALVE CONTROL HOUSE

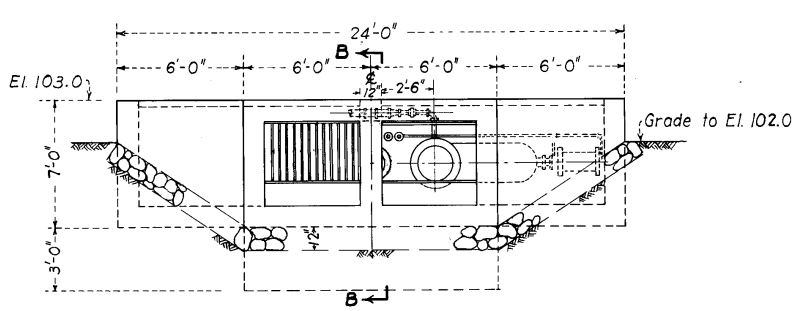
DRAWN N.L.L. APPROVED
TRACED F.B.C. APPROVED
CHECKED O.K. APPROVED
DIRECTOR OF PUBLIC WORKS AND PLANNING
CITY MANAGER

DENVER, COLORADO MAY 1947 | 705-32

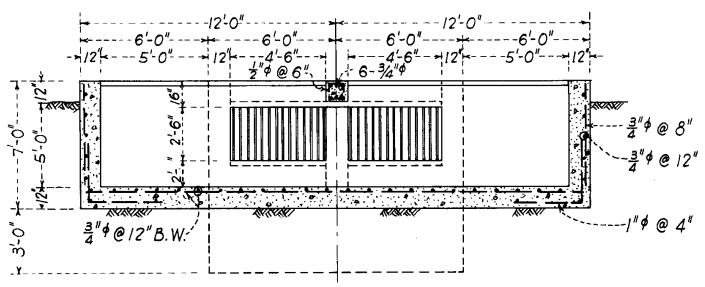
C-454



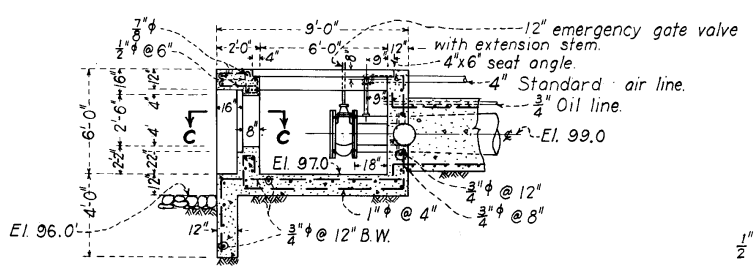
PLAN



FRONT ELEVATION

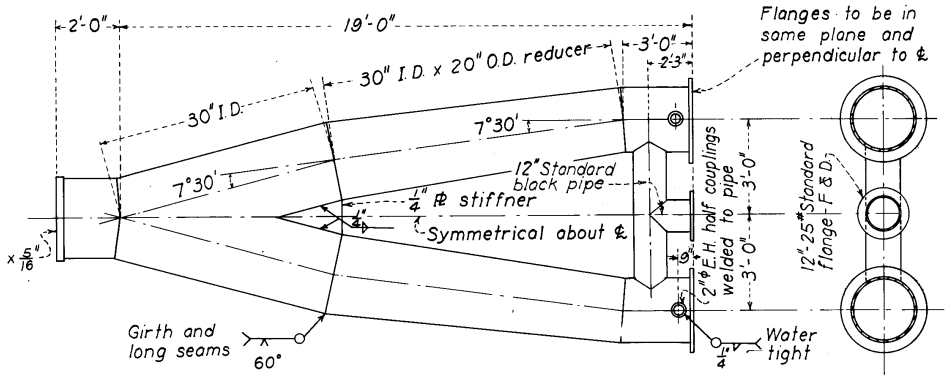


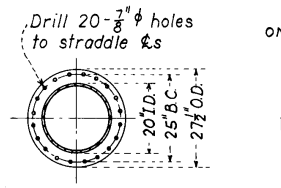
SECTION A-A



SECTION B-B
TRASHRACK STRUCTURE

SCALE OF FEET 1 0 5 10

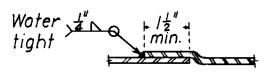




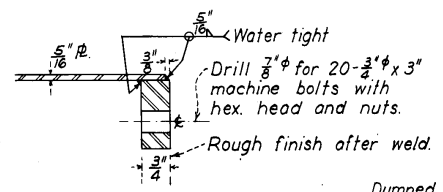
20" DRILLING TEMPLATE

OUTLET WYE
ONE REQUIRED
MATERIAL 5/16" ℄

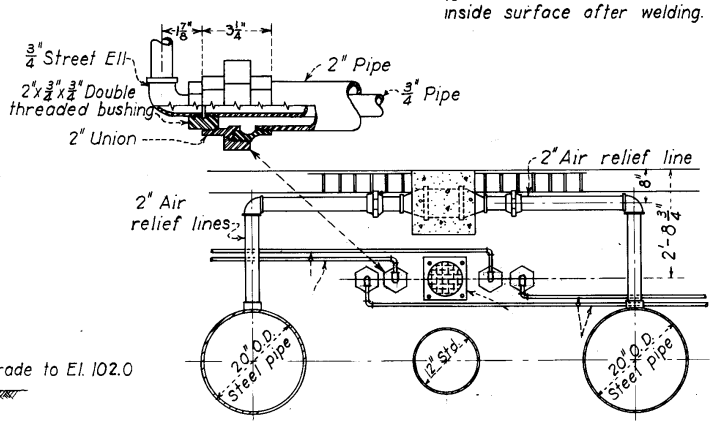
SCALE OF FEET 1 0 1 2 3 4 5 6 7



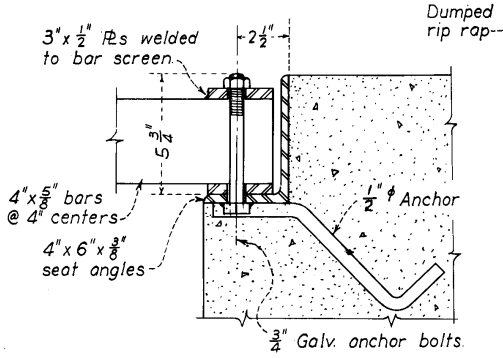
TYPICAL FIELD WELD
1/16" max. allowable offset of inside surface after welding.



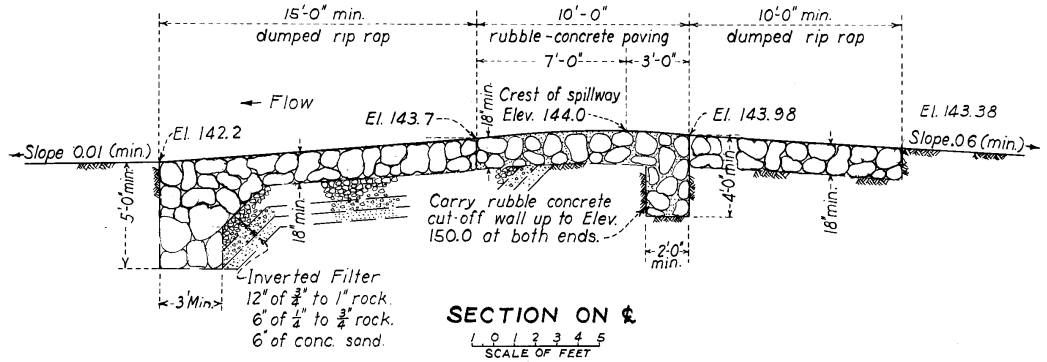
20" FLANGE DETAILS



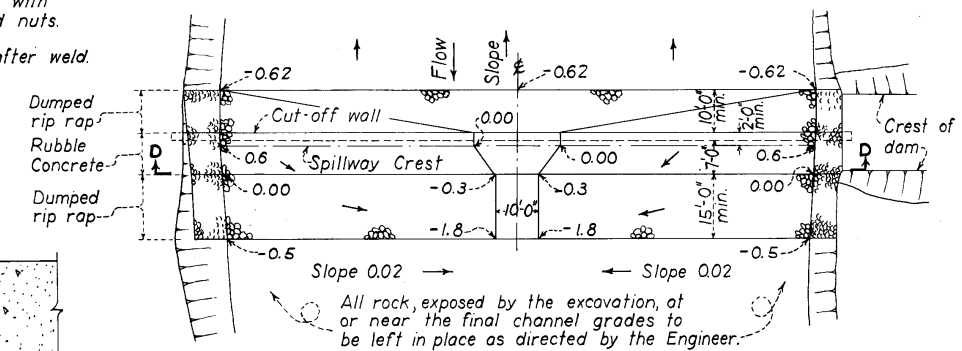
PIPING DETAILS FOR TRASHRACK STRUCTURE



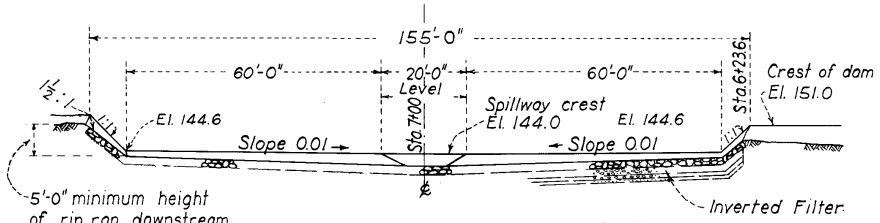
DETAIL OF TRASHRACK SEAT



SECTION ON ℄
SCALE OF FEET 1 0 1 2 3 4 5



PLAN



TRANSVERSE SECTION D-D
SPILLWAY DETAILS

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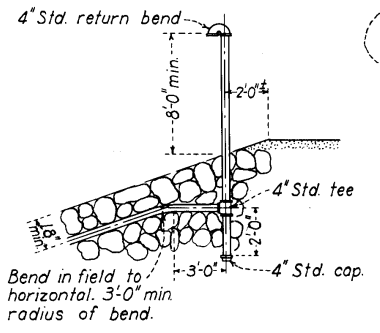
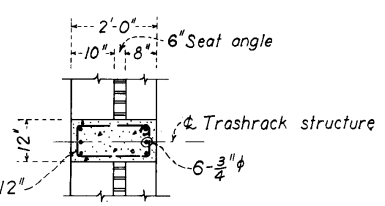
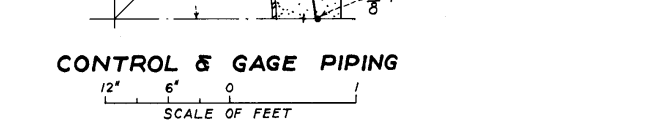


AIR VENT STACK

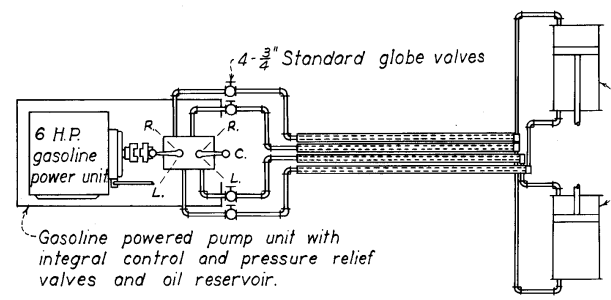


SECTION C-C



CONTROL & GAGE PIPING

SCALE OF FEET 12" 6" 0 1'



VALVE CONTROL PIPING DIAGRAM

NOTES

Steel outlet pipe, hydraulic gate valves, oil piping, pressure gauge piping, air vent piping and trashrack metal work to be furnished by the City.

Approved on the 24 day of May 1947.

By M. C. Hinderlider
STATE ENGINEER

By
DEPUTY

CITY OF GRAND JUNCTION
R.J. TIPTON AND ASSOCIATES INC., ENGINEERS
DENVER, COLORADO

IMPROVEMENTS TO WATER SUPPLY SYSTEM
HOGCHUTE RESERVOIR
TRASHRACK STRUCTURE
AND SPILLWAY DETAILS

DRAWN N.L.L.	APPROVED	R.J. TIPTON AND ASSOCIATES, INC.
TRACED F.B.C.	APPROVED	DIRECTOR OF PUBLIC WORKS AND PLANNING
CHECKED O.K.	APPROVED	CITY MANAGER

DENVER, COLORADO MAY 1947 | 705-33

C-454

COMPREHENSIVE DAM SAFETY EVALUATION REPORT
Hogchute Dam, DAMID 420127
State of Colorado, Division of Water Resources

COLORADO
Division of Water Resources
Department of Natural Resources

STATE OF COLORADO, DIVISION OF WATER RESOURCES, DAM SAFETY BRANCH

Comprehensive Dam Safety Evaluation Report

Hogchute (aka Carson Lake) Dam, DAMID 420127

High Hazard

Mesa County, CO

Water Division 4, Water District 42

Revised: February 6, 2018

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APPENDICES

1. PROCESS OVERVIEW, EXECUTIVE SUMMARY, AND SAFE STORAGE LEVEL DETERMINATION

The Comprehensive Dam Safety Evaluation (CDSE) report is a Colorado Dam Safety tool to consider all available information about a particular dam within a Potential Failure Modes Analysis (PFMA) and Semi-Quantitative Risk Assessment (SQRA) framework to determine the Safe Storage Level in accordance with Colorado Revised Statute 37-87-107, which assigns the State Engineer the responsibility to determine the safe storage level for all reservoirs in the State. The CDSE process has been developed by Colorado Dam Safety along with dam engineering and risk assessment expert consultants, and is generally based on the U.S. Bureau of Reclamation's *Best Practices in Dam and Levee Risk Assessment* (2015) and FEMAP-1032 *Evaluation and Monitoring of Seepage and Internal Erosion (2015)*.

1.1. Dam Safety "Risk" and CDSE Process Overview

In a dam safety context, "Risk" is a product of the *Likelihood* of a specific potential dam failure mode (PFM) and the *Consequences* following the occurrence of that PFM. The CDSE endeavors to quantify the overall Risk of a given dam by assigning relative values to both the Likelihood and Consequences of all plausible PFMs through a highly detailed review of all "known" information, while also acknowledging the existence and potential impact of "unknown" variables.

The CDSE process starts with a detailed review of State Engineer's Office (SEO) dam safety files including: construction history, past investigations and analyses, performance history (past inspections & incidents), and monitoring results (seepage, piezometers, etc.). All of the researched and documented information is then used to evaluate industry-standard PFMs and generate a list of plausible PFMs for the subject dam. Each PFM includes a detailed description of mechanisms by which dams can and do fail, with detailed steps that must occur from initiation to dam failure. For each PFM, adverse and positive factors are considered by the evaluation team and an overall Likelihood is assigned. "Unknown" variables are factored into the evaluation by assigning a Confidence rating for each PFM. "Poor" and "Medium" Confidence ratings are typically accompanied by actions that could be taken to raise the overall confidence rating of the PFM. Once the Likelihood level is assigned, a Consequence level is determined and assigned. The dam safety industry generally determines Consequences with potential lives lost or "Population At Risk" (PAR) in the downstream floodplain, though impacts to infrastructure and/or environmental damages could also be considered.

Each PFM is then plotted on a Risk Chart based on the assigned Likelihood and Consequence levels as a means of determining which PFMs are most alarming ("Risk Driving") from a dam and public safety perspective. The Risk Driving PFMs will tend to plot higher and further to the right of the Risk Chart, while non-Risk Driving PFMs will be lower and further to the left. The Risk Chart can also be used as a prioritization tool when extensive repairs are anticipated for a given dam or portfolio of dams.

The CDSE report serves as a single summary document for a given dam. The report includes a summary of the dam history, key properties of the dam, expected consequences of dam failure, emergency preparedness, and key risk factors associated with the dam based on the PFMA results.

1.2. CDSE Summary for Hogchute (aka Carson Lake) Dam

For Hogchute Dam, 26 PFMs were evaluated with the "Risk-Driving" PFMs identified as:

PFM #2: Backward Erosion Piping through the Embankment,

PFM #7: Contact Erosion through the Foundation,

PFM #12 Concentrated Leak Erosion along the Conduit,

PFM #13 Concentrated Leak Erosion into the Conduit,

PFM #15 Overtopping, and

PFM #26 Outlet Gate(s) Fail to Open

These risk-driving PFMs were then thoroughly evaluated by a team of engineers including the Colorado Dam Safety Chief and two dam safety engineers within Colorado Dam Safety. Section 3 of this report contains a summary of the PFMA results. The individual PFM worksheets including adverse and positive factors that were considered for each PFM are included in Appendix A.

1.2.1. Likelihood Level Assignments

By consensus of the group, a HIGH Likelihood of failure was assigned to PFM #12 Concentrated Leak Erosion into the Conduit, PFM #15 Overtopping, and PFM #25 Outlet Gate(s) Fail to Open, when the reservoir is at full storage. A HIGH Likelihood means the fundamental condition of defect is known to exist, indirect evidence suggests it is plausible, and *key evidence is weighted more heavily toward likely than unlikely.*

By consensus of the group, a MODERATE Likelihood of failure was assigned to PFM #2 Backward Erosion Piping through the Embankment, PFM #7 Contact Erosion through the Foundation, and PFM # 13 Concentrated Leak Erosion into the Conduit, when the reservoir is at full storage. A MODERATE Likelihood means the fundamental condition of defect is known to exist, indirect evidence suggests it is plausible, but *key evidence is weighted more heavily toward unlikely than likely.*

A summary description of PFM Likelihood ratings is provided for reference in Appendix F.

The HIGH and MODERATE Likelihood of these PFMs were predominantly driven by direct and indirect evidence indicating that each PFM is credible, poses a significant risk to the safety of the dam, and that action is needed to either reduce the risk or better define the risk. Key evidence supporting these determinations include:

- Long history of observed seepage at the downstream toe of the dam behind the outlet pipe headwall (PFMs #2, #7, and #12).
- Long history of observed seepage along the downstream right abutment (PFMs #2, and #7).
- Suspected air vent penetration broken and causing up to 3cfs infiltration into the outlet pipe (PFM #13).

- No known hydrology study on file (PFM#15).
- Concern over long-term integrity of hydraulic controls and unknown condition of the outlet gates and intake structure (PFM #26)

1.2.2. Consequence Level Assignment

By consensus of the group, all of the HIGH and MODERATE Likelihood PFMs fall in Level 2 or Level 3 consequences. Level 2 consequences indicate a magnitude of downstream discharge results in moderate property damage with possible direct loss of life in the range of 1 to 10. Level 3 results in moderate property damage with direct loss of life in the range of 10 to 100. For each PFM, the determination of consequence level 2 or 3 was estimated by the anticipated full or only partial breach of the dam, respectively.

1.2.3. Required Risk Reduction Actions

The combination of a HIGH or MODERATE Likelihood and LEVEL 2 or 3 Consequences warrants risk reduction measures to improve the safety of the dam. However, risk-driving PFMs #12 and #15, and #3 and #7 fall into the Confidence Level of POOR or POOR to MEDIUM, indicating that specific information is lacking in order to adequately characterize the risk of the project (Section 4.5, FEMA P-1032, May 2015). For PFMs #13 and #26, the Confidence Level is MEDIUM to STRONG may require immediate action to reduce the risk. The Strong component of this split ranking indicates compelling evidence of an ongoing or active failure mode, while the Medium level indicates additional information is needed to adequately assess the risk.

For Colorado Dam Safety, one risk reduction measure is impose a storage restriction in accordance with the State Engineer's authority and responsibility to protect the downstream public per CRS 37-87-107. Based on engineering judgment, consideration of all information detailed herein, and in good faith, *Colorado Dam Safety has determined that a storage restriction for Hogchute Dam is not warranted at this time. However, diligence must be shown to obtain additional information to increase the confidence of all the risk-driving PFMs identified in this CDSE study.*

By consensus of the group, the Actions and Due Dates in Table 3.2 are measures necessary to either reduce the risk of failure of the dam by a PFM or requirements for obtaining additional information to increase the Confidence Level of a PFM. *Compliance with the Actions shown in Table 3.2 by the associated Due Date is required to reduce the risk in a timely manner. Failure to do so, may result in a storage restriction action by the State Engineer to reduce or remove the risk associated with each identified PFM.*

A summary of Risk Reduction Action requiring an engineer are provided in Table 5.2.1 *Dam Failure Likelihood Reduction Actions*

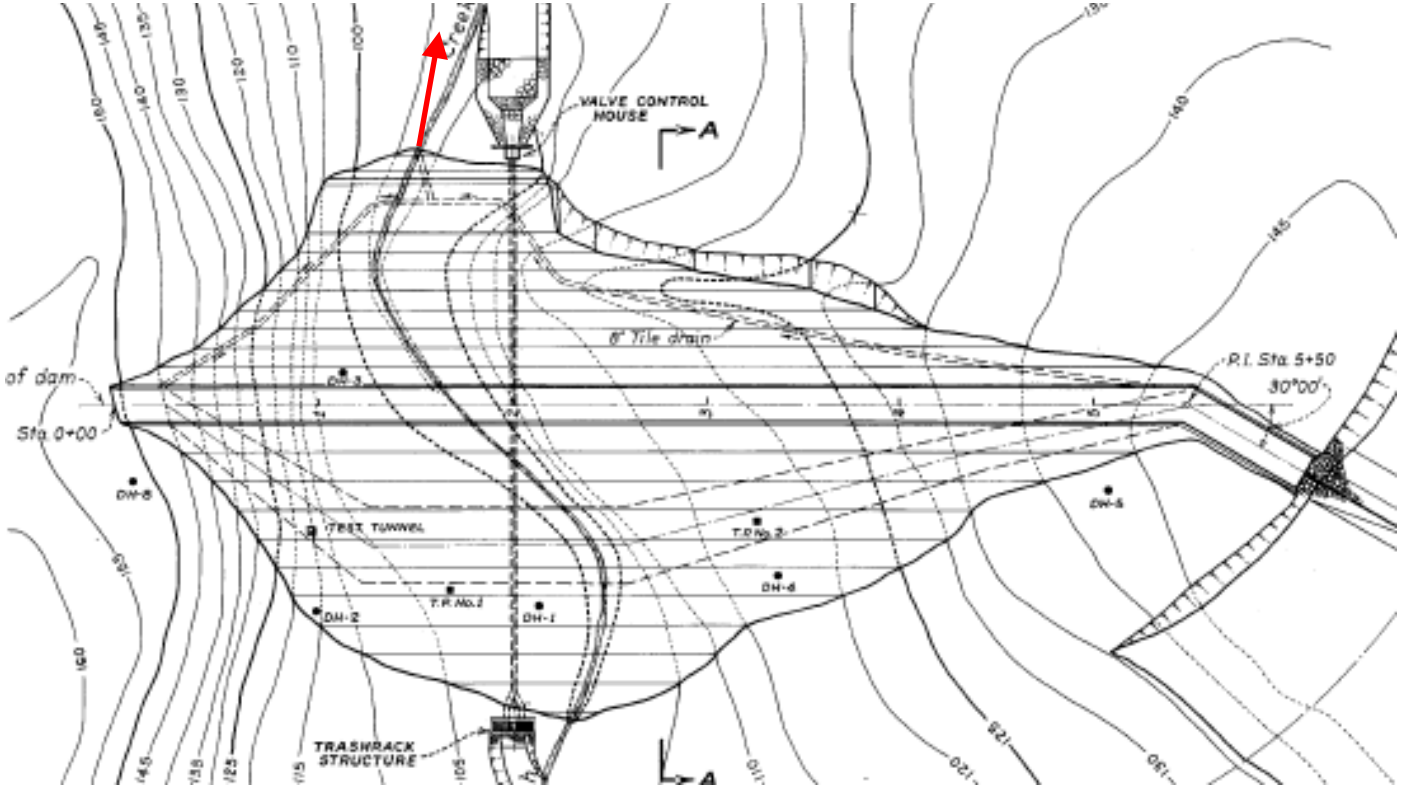
2. BACKGROUND DOCUMENTATION

2.1. Summary of Facility - Current Configuration - General Summary Only

Feature	Description
Dam Name	Hogchute, aka Carson Lake
State of Colorado DAMID	420127
Dam Owner	City of Grand Junction
Dam Purpose	Municipal and Irrigation
Type of Dam	EARTHEN, Homogeneous impervious core (Zone 1) with upstream and downstream cobble and rock fill shells (Zone 2). Cutoff trench, offset upstream of dam axis.
Hazard Classification	High
County	Mesa
Nearest Town	Whitewater
UTMx. UTMy	230460.5, 4320830.6
River or Stream	Kannah Creek
Dam Geometry	
Dam Structural Height	56 ft
Dam Hydraulic Height	56 ft
Crest Length	620 ft
Crest Width	18 ft
Dam Crest Elevation	9,890 ft
Reservoir	
Surface Area	35 acres at normal high waterline
Normal Capacity	637 acre-feet
Maximum Capacity	765 acre-feet
Pool of Record	Unknown.
Outlet Works	
Outlet Description	30-inch, Welded Steel Pipe; Two 20-inch hydraulic gates One 12-inch gate emergency valve between outlet wye (See C-454, Sht 705-33)

Feature	Description	
Outlet Capacity	134 cfs	
Drawdown time	-	
Spillway		
Drainage Basin Area	6,240 acres	
Total Spillway Capacity	2,400 cfs in DAMS database; 7500 cfs per original design report (1947).	
Capacity / Sq mi	-	
	Principal Spillway	*Emergency Spillway*
Type	-	Ungated, open channel
Width	-	140 ft
Freeboard	-	7 feet
Discharge Capacity	-	2,400 cfs?

2.2. Summary of Construction History

Date	C #	Brief Description
1947	C-454	• Plans and specifications submitted May 1947. • State Engineer Hinderlider signed approval block on C-454 May 1947 • Work began July 1947 • Winter shutdown 1947 planned, but all work completed (by letter) on dam by November 15, 1947 • No follow-up as-constructed drawings or other documentation in file.
1972	-	• DWR Inspection Report: "In 1972, a new outlet control was established. The gates are hydraulically operated. The operating gear is in a shed on the upstream crest".
1988	-	 • Toe drain discharge excavated and extended into 40-downstream along left side of discharge channel (red arrow above) • Seepage from right side behind headwall "traced to the tubes which were installed for reservoir level gauge in the old valve house" (letter from City of Grand Junction to Jim Norfleet, Nov 14, 1988). • Headwall repaired and tie-back cable installed.

2.3. Summary of Investigations, Designs, & Analyses

Report Type	In File? (Y/N)	Author, Date	Brief Summary
Hazard Classification			
National Dam Safety Program Hazard Classification Determination	Yes	Van Sciver, 1979	• Limited hazards based on aerial flight photography • Moderate hazard rating (Significant hazard per 2007 Rules and Regs) • Qp at dam estimated at 8,516 cfs
Hazard Re-evaluation	Yes	Ahrens, 1985	• Qp at dam estimated at 7,193 cfs • Moderate rating; No change
Inundation Mapping Study	Yes	City of GJ, 2015	• Qp at dam estimated at 28,927 cfs (per Froehlich, 2008 and WA State, 2007 methods) • New residential development since last evaluations • High Hazard rating
Spillway			
	No		See Section 5.1 Summary of Key Risk Factors for summary of known information
Geotechnical			
Geology	No		Colorado Geological Survey GoogleEarth KML file indicates dam is situated on Landslide deposits with bordering units of Green River Formation to the north and Glacial drift to the south.
Subsurface	No		Eight borehole logs contained on C-454, Sht 705-31 See Section 5.1 Summary of Key Risk Factors for summary of known information
Seismicity	No		PGA = 0.1591g per USGS See Section 5.1 Summary of Key Risk Factors for summary of known information
Stability	No		
Seepage	No		See Section 5.1 Summary of Key Risk Factors for summary of known information
Filter design	No		
Outlet Works			
	Y	C-454 (1947)	Outlet works design drawings only.

2.4. Summary of Performance History, Incidents & Significant Noted Deficiencies

Date	Description of Deficiency	Action Taken	Resolved?	Reference
1971 and 1972	• First inspections of dam both note seepage from right toe of dam above outlet structure • 1972 inspection notes seepage between outlet pipe and concrete and penetration through headwall			A. Pearson, Dam Safety inspection reports
1975, 1976	• Similar observations of seepage noted			DWR inspection reports
8/12/1975	• DWR Inspection Report: "In 1972, a new outlet control was established. The gates are hydraulically operated. The operating gear is in a shed on the upstream crest".			
1977	• Inspection report notes condition of outlet works "good-recently redone"			
1984	• First inspection report to denote abandoned Control House at downstream toe of dam. Inspection indicates valve operation controls are on the upstream slope. • Seepage from right toe of dam noted.			B. Ahrens, DWR inspection report
1985 - 1987	• Inspection reports note generally same conditions for seepage from right toe and seepage and deteriorating conditions at downstream headwall.			
1985-1987	• First inspection reports with observation of deteriorating spillway crest and water flowing under "rubble concrete paving" (description from C-454, Sht 705-33)			
1988	• Inspection report: Exposed rebar around outlet pipe penetration through headwall			J. Norfleet
1988	• **Summary of repairs by City of Grand Junction:** 2. THE CREW THEN LOCATED THE END OF THE TOE DRAIN PIPE AND FOUND THAT IT WAS SUBMERGED 2 FEET BELOW THE STREAM BED LEVEL. IN AN EFFORT TO PROVIDE AS MUCH DRAINAGE CAPABILITY AS POSSIBLE THE PIPE WAS EXTENDED DOWNSTREAM 40 FEET, THIS STILL LEAVES THE END OF THE PIPE SUBMERGED HOWEVER IT DOES ALLOW FOR SOME RELIEF OVER THE ORIGINAL POINT OF EXIT. 3. SEEP WATER AROUND THE OLD VALVE HOUSE WAS TRACED TO THE TUBES WHICH WERE INSTALLED FOR RESERVOIR LEVEL GAUGE IN THE OLD VALVE HOUSE, THIS SOURCE OF WATER WAS SEALED OFF AND THE SEEP WATER WAS REDUCED TO LESS THAN 1/2 GALLON PER MINUTE.			City of Grand Junction, November 14, 1988

Date	Description of Deficiency	Action Taken	Resolved?	Reference
1989, 1990, 1991, 1992, 1993, 1995, 1996	Inspection Reports • Seepage from right toe above outlet pipe headwall; generally consistent observations. • No notes of observing left side toe drain outfall • Deterioration of downstream headwall continues • Outlet works difficult to operate, but acceptable. • Some observations and distinction between "right abutment" versus area behind headwall seepage.			J. Norfleet
1997	• Observation of seepage from outlet pipe penetration through headwall (not mentioned in recent previous years, but likely occurring).			J. Norfleet
1998	• Toe drain extension found and photographed along left edge of discharge channel.			J. Norfleet
1998	• "left toe drain submerged in outlet channel, but flowing" • Right abutment seepage and behind headwall observed			J. Norfleet
1999, 2000, 2002	• Seepage observations lean toward right abutment seepage is source of ponded water behind headwall			G. Jackson
2004	• Generally same observations from previous years.			G. Jackson
2006	• Note that left toe drain outfall is submerged.			G. Jackson

2008	• Internal inspection of the outlet pipe.
	• Inspection Report:
	  ○ Video inspection revealed air vent leakage (approx. 1.8 cfs) observed
	  ○ No photos of air vent leak in file.
				G. Jackson

2010	• No significant changes reported			G. Jackson
2011	• No significant changes reported			G. Jackson
2013	• Concern noted that operation of the outlet increases seepage behind the headwall			G. Jackson

2013	• Follow-up inspection to exercise valves and observe seepage
	  ○ Both valves exercised through full range
	  ○ No observed increase in seepage
				G. Jackson

Date	Description of Deficiency	Action Taken	Resolved?	Reference
2015	• Improved drainage behind headwall			G. Jackson
2016, 2017	• Owner directed to engage engineer to investigate seepage and outlet works deficiencies and plan for repair.			G. Jackson

2.5. Summary of Operations

Type	Y/N	Description	Adequacy/ Confidence
Owner Participation			
Owner Dam Safety Program	N	No formal program in place.	Acceptable
Dam Caretakers	Y/N	No one on-site, but approximately weekly visits to the dam.	Acceptable
Owner Inspections	Y	Owner performs site inspections during routine water release adjustment and maintenance	Acceptable
Owner Monitoring of Instruments	Y/N	Owner indicates seepage monitoring, but no known data reduction or submittal to CO Dam Safety	Poor
Outlet Operations			
Upstream Control	Y	Two hydraulically operated gate valves.	Acceptable
Routine Exercising	N		Poor
Routine Internal Inspections	Y	Last internal inspection in 2008; due in 2018	Good
Reservoir & Spillway Operations			
Normal Operating Procedures	Y	Reservoir fills and spills in spring due to normal runoff. Reservoir lowered during irrigation season Outlet fully closed in fall to retain next spring runoff.	Acceptable
Pool of Record		Unknown	Acceptable
Spillway Activated Normally		Yes	Acceptable

2.6. Summary of Monitoring & Instrumentation

Instrumentation Type	Monitoring Frequency	Reporting to SEO?	Analysis of Data?	Discussion of Trends
Staff gage	Unknown	No	No	Welds on hydraulic lines casing; generally unreadable
Survey Monuments	No Known			
Piezometers	None			
Seepage	Unknown	No? / Unknown	Unknown	See above
Other				

3. POTENTIAL FAILURE MODES ANALYSIS

3.1. PFM Brainstorm/Screening List

PFM Suite	PFM #	PFM Name	General PFM Description	PFM Carried Forward or Remote	Justification for Carried Forward (Credible) or Remote (Non-Credible)
Internal Erosion Through Embankment	1.	Concentrated Leak Erosion through Embankment	a crack above an abrupt change in rock slope on an abutment, an hydraulic fracture crack in a low stress zone in the core, a desiccation crack, differential settlement cracking, a frost damaged layer at a winter shutdown level, the boundary in the embankment created by a closure section, defects due to animal burrows or roots	Remote	No evidence of concentrated embankment seepage in field or from file review.
	2.	Backward Erosion Piping through Embankment	a low plasticity (PI<7) layer or zone through the core, dispersive soil	Carry Forward	Historic seepage emerging from downstream toe of dam behind the outlet pipe headwall; Downstream shell may not be filter compatible with core of dam.
	3.	Contact Erosion through Embankment	pervious zone above core, embankment overlying pervious foundation	Carry forward	Historic seepage emerging from downstream toe of dam behind the outlet pipe headwall and along right abutment.
	4.	Suffusion/Suffosion through Embankment	presence of internally unstable soil	Carry forward	No evidence, but need to verify before assigning remote
Internal Erosion Through Foundation	5.	Backward Erosion Piping through Foundation	a continuous pervious, low plasticity (PI<7) layer through the foundation, direct entrance into pervious layer, open exit or heave/blowout, dispersive soil	Remote	No evidence of PFM in field or from file review Clay foundation likely has PI>7 This PFM could also be captured in PFM#7 below.
	6.	Concentrated Leak Erosion through Foundation	a crack above an abrupt change in rock slope, an hydraulic fracture crack in a low stress zone, differential settlement cracking, crack due to collapsible soil, karstic features, open or erodible bedrock discontinuities	Remote	No evidence of PFM in field or from file review
	7.	Contact Erosion through Foundation	Flow through pervious foundation layer underlying fine-grained confining layer: Foundation seepage path consisting of a system of high-porosity interconnected and open rock fractures, solution cavities, open coarse material, or a fault system	Carry Forward	Historic seepage emerging from downstream toe of dam behind the outlet pipe headwall ; Original drill logs (C-545) show potentially gap-graded clay/rock foundation
	8.	Suffusion/Suffosion through Foundation	presence of internally unstable soil	Remote	No evidence of PFM in field or from file review
Internal Erosion of Embankment Into Foundation	9.	Concentrated Leak Erosion	Coarse open-work foundation soils (gravels/cobbles), voids, karstic features, untreated open rock fracture	Remote	No evidence of PFM in field or from file review
	10.	Backward Erosion Piping	a low plasticity (PI<7) layer near the core base, filter incompatibility between embankment and foundation soils, dispersive soil	Remote	No evidence of PFM in field or from file review
Internal Erosion of Embankment at *Contact*	11.	Concentrated Leak Erosion	Hydraulic fracture occurs along low stress zones (along a steep wall or low compaction zones) or gap developing due to settlement of dam fill adjacent to rigid structure	Remote	No evidence of PFM in field or from file review
Internal Erosion *along* Conduit	12.	Concentrated Leak Erosion	Examples of a defect along a conduit include a crack, void, or zone of low compaction density due to shape of conduit or presence and configuration of seepage collars	Carry Forward	Historic seepage emerging from downstream toe of dam behind the outlet pipe headwall.
Internal Erosion *into* Conduit/Drain	13.	Concentrated Leak Erosion	Examples of a defect along a conduit include a crack, hole, open pipe joint, slots/perforations cut too large for surrounding soil, or other opening that is in a strategic part of the embankment and below the phreatic surface. This hole may be in alignment with an existing flaw in the embankment along the conduit that connects to the reservoir	Carry forward	Suspected air vent penetration broken and causing up to 3 cfs infiltration into outlet pipe.
Internal Erosion *out of* Conduit	14.	Concentrated Leak Erosion	Examples of a defect along a conduit include a crack, hole, open pipe joint, slots/perforations cut too large for surrounding soil, or other opening that is in a strategic part of the embankment and below the phreatic surface. This hole may be in alignment with an existing flaw in the embankment along the conduit that connects to the reservoir	Carry forward	Need to verify before assigning remote. Need to compare findings with PFM#13
Overtopping	15.	Overtopping	Example causes for exceeding spillway capacity include undersized spillway, debris blockage, misoperation, or failure of a gate hoist/chain/valve	Carry forward	Large spillway with relatively small drainage area, but Low Confidence without hydrology study.

PFM Suite	PFM #	PFM Name	General PFM Description	PFM Carried Forward or Remote	Justification for Carried Forward (Credible) or Remote (Non-Credible)
Spillway Failure due to Erosion	16.	Erosion of Unlined Channel	Overflow duration, depth, and velocity initiate head-cutting erosion of the earthcut spillway channel	Remote	Spillway located on natural abutment; Remote chance of eroding to stream level.
	17.	Undercutting of Spillway Structure	Failure of the structural portion of the spillway	Remote	Evidence of crest structure deterioration, but spillway located on natural abutment; Remote chance of eroding to stream level.
Reservoir Landslide/Seiche Leading to Overtopping	18.	Reservoir Landslide/Seiche Leading to Overtopping	The size and velocity of the landslide mass is sufficient to create a wave/seiche that overtops the dam with multiple waves.	Carry forward	Need to verify before assigning remote
Static Slope Stability	19.	Rise in Phreatic Level Causes Deformations that Exceed Freeboard	Phreatic level rises due to filter or toe drain clogging, long-duration flood loading, saturation of slope from surface run-on or precipitation infiltration.	Carry forward	Need to verify before assigning remote
	20.	Slump Reduces Seepage Path Leading to Internal Erosion	Phreatic level rises due to filter or toe drain clogging, long-duration flood loading, saturation of slope from surface run-on or precipitation infiltration - > Deformations are less than freeboard, but seepage and internal erosion initiates through the slide mass / scarp.	Carry forward	Need to verify before assigning remote
	21.	Rapid Drawdown Failure of Upstream Slope	The reservoir is lowered faster than pore pressures can dissipate in upstream materials. Consider that freeboard is very large once reservoir is drawndown, and thus deformations would need to be great to lead to loss of reservoir.	Carry forward	Need to verify before assigning remote
Seismic Deformation	22.	Dynamic Deformation Greater than Freeboard	Significant reduction in foundation strength due to liquefaction of low plasticity and cohesionless soils. Also consider cohesive, plastic soils susceptible to significant strength loss due to strain-softening.	Carry forward	Need to verify before assigning remote
	23.	Differential Settlement Leads to Transverse Cracking	Differential settlement (less than freeboard) caused by foundation and embankment irregularities including abrupt change in foundation depth or density, abrupt change in embankment height due to valley shape, collapsible soils	Carry forward	Need to verify before assigning remote
	24.	Dynamic Separation at Contact Leads to Internal Erosion	Separation at contact between embankment and rigid structure (concrete section, spillway or retaining wall, steep rock abutment) due to differential dynamic response	Remote	No rigid structures for this PFM. Deformation can be captured in PFM#22 and/or
Outlet Works	25.	Outlet Gate(s) Fail to Close	Uncontrolled release of reservoir through the outlet conduit. Other PFMs may initiate, but not due to failure of outlet gates to close.	Remote	Concern over long-term integrity of hydraulic controls. Unknown condition of outlet gates and intake structure.
	26.	Outlet Gate(s) Fail to Open	Unable to release reservoir causes long-term normal storage that can lead to favorable conditions for initiation of other PFMs.	Carry Forward	Concern over long-term integrity of hydraulic controls. Unknown condition of outlet gates and intake structure.

3.2. Risk Driving Potential Failure Modes Summary Table[1]

PFM #	PFM Name	Likelihood	Confidence	Actions	Initial Date	Due Date
2	Backward Erosion Piping through Embankment	Moderate	Poor to Medium	Seepage Investigation; attempt to trace and isolate source(s) of seepage	DD/MM/YYYY	DD/MM/YYYY
				Geotechnical investigation included drilling, sampling, and soil index testing of Zone 1 material	DD/MM/YYYY	DD/MM/YYYY
				Piezometer installation in Zone 1	DD/MM/YYYY	DD/MM/YYYY
				Improve seepage collection and monitoring	DD/MM/YYYY	DD/MM/YYYY
7	Contact Erosion through Foundation	Moderate	Poor to Medium	Same Actions as PFM#2	DD/MM/YYYY	DD/MM/YYYY
				Add foundation depth drilling and sampling	DD/MM/YYYY	DD/MM/YYYY
12	Concentrated Leak Erosion *along* the Conduit	High	Poor	Same Actions as PFM#2	DD/MM/YYYY	DD/MM/YYYY
13	Concentrated Leak Erosion *into* the Conduit	Moderate	Medium to Strong	Drain the reservoir to investigate the air vent connection(s)	DD/MM/YYYY	DD/MM/YYYY
				Perform internal inspection of the outlet to confirm condition • With storage to confirm leakage into/out of conduit • Without storage to observe dewatered dry conduit	DD/MM/YYYY	DD/MM/YYYY
15	Overtopping	High	Poor	Perform hydrology study to determine IDF and spillway adequacy.	DD/MM/YYYY	DD/MM/YYYY
26	Outlet Gate(s) Fail to Open	High	Medium to Strong	Drain the reservoir and investigate the condition of the hydraulic controls. Decide whether to repair or replace.	DD/MM/YYYY	DD/MM/YYYY

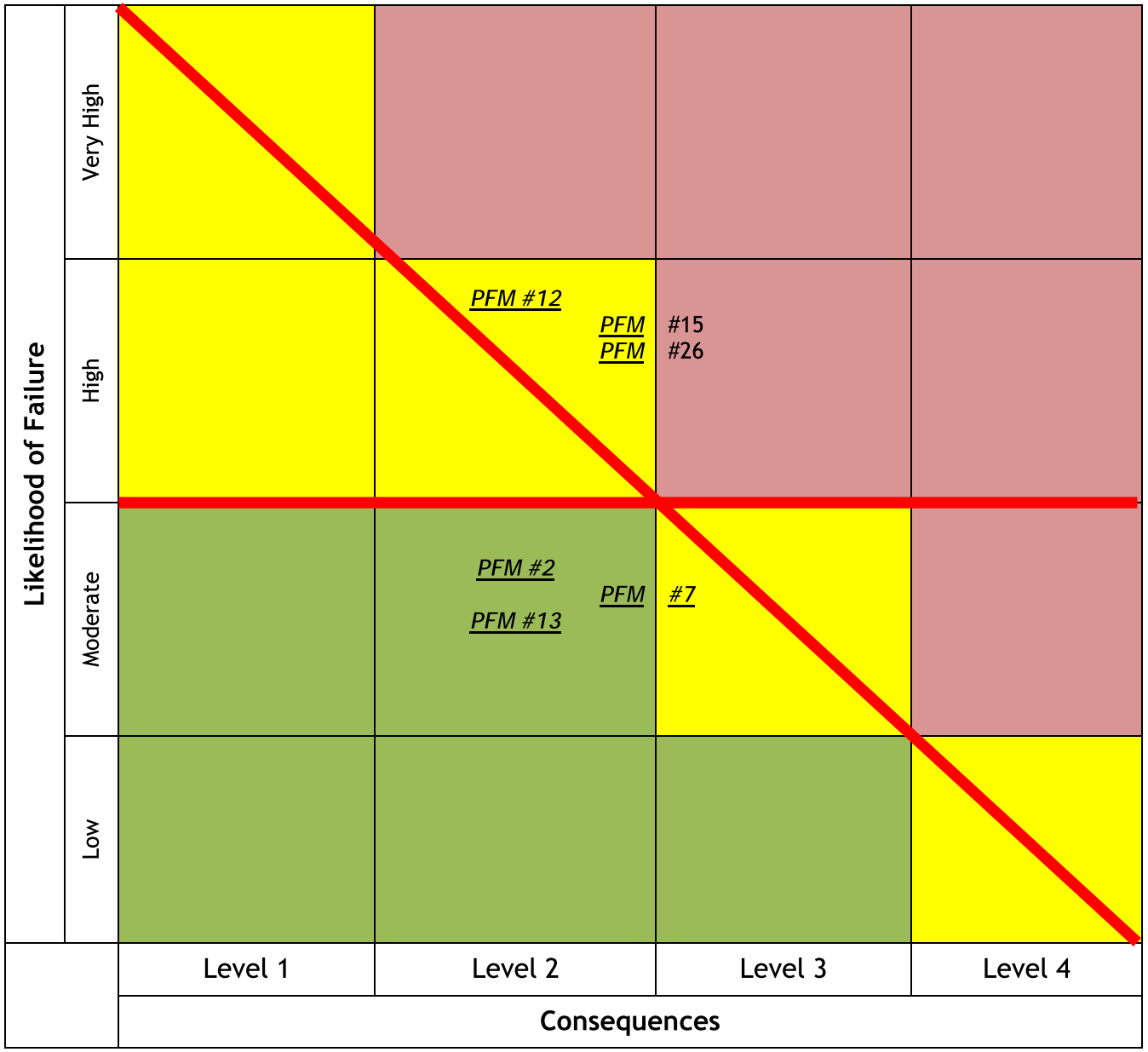
[1] Potential Failure Modes judged Very High, High, Moderate Likelihood require actionable items to reduce probability of failure and reduce consequences associated with that Potential Failure Mode. Actions for Very High, High, and Moderate likelihood will be tracked until the PFM's fall into the Low or Remote category.

3.3. Non-Risk Driving Potential Failure Modes Summary Table[2]

PFM #	PFM Name	Likelihood	Confidence	Actions
3	Contact Erosion through Embankment		Poor	• Pursue this PFM after geotechnical investigation and only if PFM#2 likelihood and confidence increases.
4	Suffusion/Suffosion through Embankment		Poor	• Pursue this PFM if geotechnical investigation likelihood supports PFM as credible.
14	Concentrated Leak Erosion out of Conduit		Poor	• Pursue this PFM only if internal inspection of outlet supports PFM as credible.
18	Reservoir Landslide/Seiche Leading to Overtopping		Poor	• Geological site and seismic evaluations needed. Pursue only if future analysis supports PFM as credible.
19	Rise in Phreatic Level Causes Deformations that Exceed Freeboard		Poor	• Static slope stability evaluation required for High hazard dam. Pursue this PFM if geotechnical investigation likelihood supports PFM as credible.
20	Slump Reduces Seepage Path Leading to Internal Erosion		Poor	• Static slope stability evaluation required for High hazard dam. Pursue this PFM if geotechnical investigation likelihood supports PFM as credible.
21	Rapid Drawdown Failure of Upstream Slope		Poor	• Pursue this PFM if geotechnical investigation likelihood supports PFM as credible.
22	Dynamic Deformation Greater than Freeboard		Poor	• Seismic evaluation required for High hazard dam. Pursue this PFM if geotechnical investigation likelihood supports PFM as credible
23	Differential Settlement Leads to Transverse Cracking		Poor	• Seismic evaluation required for High hazard dam. Pursue this PFM if geotechnical investigation likelihood supports PFM as credible

[2] PFM's judged Low or Remote may require inspection & monitoring as part of normal dam safety and operations routines.

3.4. Risk Chart Summary



4. DAM FAILURE CONSEQUENCES & PREPAREDNESS

4.1. Summary of Consequences Estimation[3]

4.1.1. Seepage-Induced ("Sunny Day") Dam Breach Analysis

Item	Description
Dam & Reservoir Parameters	See file memo "Hazard Classification Review" dated December 14, 2015
Breach Estimation Methodology	Froehlich, 2008
Breach Parameters	Breach bottom width, Hb = 23.2 ft 1H:1V side slopes Time to failure, tf = 0.31 ft Initial water surface elevation at time of breach = 9,883 ft
Q_p	27,650 cfs just below dam.
Population At Risk (PAR)	<100
Social Vulnerability Index (SVI)	-

Anticipated Infrastructure Impacts			
Infrastructure Description	*Distance from Dam*	*Routed Peak Flow*	*Peak Arrival Time*
See Inundation Mapping, 2015			

4.1.2. Precipitation-Induced Dam Breach Analysis

Item	Description
Dam & Reservoir Parameters	***Precipitation-Induced dam breach map has not been developed***
Breach Estimation Methodology	
Breach Parameters	
Q_p	
Population At Risk (PAR)	
Social Vulnerability Index (SVI)	

[3] Primary purpose at this time is to ensure evaluation of proper hazard classification and emergency preparedness. Decision statement does not directly consider consequences at this time.

Anticipated Infrastructure Impacts			
Infrastructure Description	*Distance from Dam*	*Routed Peak Flow*	*Arrival Time*
See Inundation Mapping, 2015			

4.1.3. Life loss & Infrastructure Impacts Estimation by PFM

PFM #	Life Loss Potential (PAR)	Estimated Infrastructure Impacts	Discussion of Warning Time	Level

4.2. Summary of Emergency Preparedness

Item	Description	Comments
Document Date & Description		
Format	Owners EAP Format, dated January 2015	Acceptable
Inundation Mapping	Yes, included in EAP	Good
Contact information	Up to date in EAP	Acceptable
Exercise Frequency	No known EAP exercise	
Site access during emergency		
Roads	Seasonal; Closed in winter	
Equipment access	Seasonal; Heavy Equipment access from FS Road	
Accessible during spillway/outlet operation	The dam and outlet works at cutoff from the main access route during spillway operation. Access to the dam would be difficult during high flows.	
Security		
General site security	Dam is located on Forest Service land; Public Access area	
Outlet operators	Offsite; City of Grand Junction Public Works	
Emergency Supplies		
Materials Availability		
Equipment Availability		

5. KEY CONCLUSIONS & RISK REDUCTION

5.1. Summary of Key Risk Factors

Risk Factor	Description	PFM #	Confidence
Hydrologic			
Flood Potential (rain depth/duration, %PMP, flood frequency, etc)	No hydrology studies in file. Quotes from original 1947 Design Report: • A flood with a frequency of once in 200 years was adopted for design of the spillway • "…flow at the dam site would be about 1040 cfs…" • It was also assumed in the design that, in addition to the peak flow tributary to the dam site, all of the small dams upstream failed, and their entire contents…passed the Hogchute Reservoir during a period of three hours". • "…required capacity of approximately 4,500 cfs with a 2-foot freeboard, and a total capacity of 7,500 cfs before the dam would be overtopped." Spillway stage-discharge contained in Table 3.	#15	Poor. No known hydrology study.
Geotechnical			
Foundation conditions	Eight (8) borehole logs contained on C-454, Sht 705-31 • Mixture of clay and clay with basalt boulders	#7	Poor
Foundation treatment	• General construction specifications • No record of construction	#7	Poor
Embankment soils	Notes on C-454, Sht 705-31: 1. Zone 1 impervious fill of clay or clay, sand and gravel graded with coarser material on outer slopes and compacted in 6" layers. 2. Zone 2 cobble and rock fill graded with coarser material on outlet slopes.	#2	
Settlement	No known settlement	-	
Slope Stability	• C-454 denotes grade break and bench on lower downstream slope. • 2017 noted only slight grade break and no bench. • No other mention of slope concerns in file history.	#19-23	
Seepage	• Right abutment seepage and standing water behind headwall; uncertain if related or separate sources. • Combined left and right toe drain with combined outfall along left side of discharge channel.	#1-11	
Filter Compatibility	• Unknown		
Other			

Risk Factor	Description	PFM #	Confidence
Seismic			
Peak Ground Acceleration (PGA): 2% in 50-YR (use PGA curve) USGS Geohazards Website	PGA = 0.1591g ; No known analysis	#22-23	
Susceptibility to liquefaction (foundation soils, Freeboard)	unknown		
Outlet Works			
Pressure flow?	No	#12-14	
Concrete encasement / carrier pipe?	Concrete encased; placed in panels with reinforcement and construction joints.		
Filter diaphragm or collar?	No known filter diaphragm		
Anti-seep collars	Yes, six (6) collars, 1-ft thick, 30-inch all around outlet pipe concrete encasement with asphalt expansion joint filler all around.		
Conduit material	30-inch I.D. 5-16" welded steel pipe		
Water-tight joints	Specifications call for coal tar coating at all welded joints.		
Valve location	Upstream		
Trash rack?	Yes, concrete intake structure with trashrack.		
Drawdown time	No known, but could be estimated.		
Gates exercised regularly thru full cycle?	No, but both gates exercised through full cycle in 2013		
Other			
Spillway			
Record Flow	Unknown		
Erosion potential	Earthen channel with some erosion observed.		
Mechanical gates or fuse plug?	No		
Slope failure/landslide susceptibility?	Unlikely		
Reservoir Operations			
Normal Seasonal Reservoir Operations	Unknown		

Risk Factor	Description	PFM #	Confidence
Record Pool	Generally fills and spills annually		
Caretaker on site?	No, but weekly site visits during the irrigation year		
Regular owner inspections?	Yes, through normal operations.		
Emergency Preparedness			
EAP current?	Yes, 2015		
Inundation mapping current?	Yes, 2015		
EAP exercised?	No		
Other			

5.2. Risk Reduction Actions[4]

5.2.1. *Dam Failure Likelihood Reduction Actions*[5]

PFM #	Required Action	Action Level/Threshold
2, 7, and 12	Retain an engineer to: SEEPAGE • Oversee seepage investigation; attempt to trace and isolate source(s) of seepage. • Find and asses condition of toe drain outfall from left side of outlet headwall. GEOTECHNICAL • Drilling and sampling program to support PFM likelihood and confidence	Develop plan to meeting Action Dates in Table 3.2
13, 26	OUTLET WORKS • Drain the reservoir to investigate air vent connection(s) and condition of outlet gates. • Perform internal inspection of outlet pipe.	Benefit of engineering oversight, but not required.
15	Retain an engineer to perform a spillway hydrologic adequacy study.	Develop plan to meeting Action Dates in Table 3.2
19-23	Retain an engineer to perform a thorough geotechnical investigation and analysis of the existing embankment, including but not limited to: • Drilling and sampling program • Static and seismic slope stability evaluation	Develop plan to meeting Action Dates in Table 3.2

5.2.2. *Consequence Reduction Actions*[6]

PFM #	Required Action	Action Level/Threshold

[4] Based on PFMA. Actions and thresholds assigned to focus effort in future inspections.
[5] "Dam Failure Likelihood Reduction Actions" include any actions that target reducing the *likelihood* of a given PFM. When completed, the action should result in a lower value for a given PFM on the *Y-axis* of the Risk Chart (Table 3.4). Actions could be temporary or permanent and might include physical changes to the dam, reservoir operational changes, or information-gathering such as engineering investigations & analyses.
[6] "Consequence Reduction Actions" include any actions targeting reducing the *impacts or consequences* of a given PFM. When completed, the action should result in a lower value for a given PFM on the *X-axis* of the Risk Chart (Table 3.4). Actions could be temporary or permanent and might include EAP updates, identification of high flow condition warnings & thresholds, acquisition of construction materials or equipment for emergency responses, or improvements to site access.

5.3. Inspection & Monitoring Checklist[7]

Required Inspection or Monitoring Action	Action Level/Threshold	PFM #

[7] Based on PFMA. Actions and thresholds assigned to focus effort in future inspections.

5.4. Summary of Operations & Maintenance Recommendations[8]

Location	Concerns	Actions	Initial Date	Due Date

[8] Conditions observed that do not directly relate to a PFM, but could lead to dam safety concerns or expensive repairs if left unattended.

Appendix A
Worksheets for Developed PFMs

1. Worksheets for Risk-Driving PFM(s)

a. *PFM #2: Backwards Erosion Piping through Embankment*

PFM Worksheet Template				
PFM #	2	**PFM Name**	Backwards Erosion Piping through Embankment	
PFM Executive Summary				
PFM Likelihood	Moderate	Likelihood Definition	PFM Date	06 February 2018
Confidence	Poor to Medium	Confidence Definition	PFM Participants	City of Grand Junction Colorado Dam Safety
Consequences	Level 2	Consequence Definition		

PFM *Likelihood* Decision: Key Factor Summary Statement

The key adverse factors of observed seepage at the downstream toe and lack of embankment soils and construction record lead the team to a likelihood of Moderate.

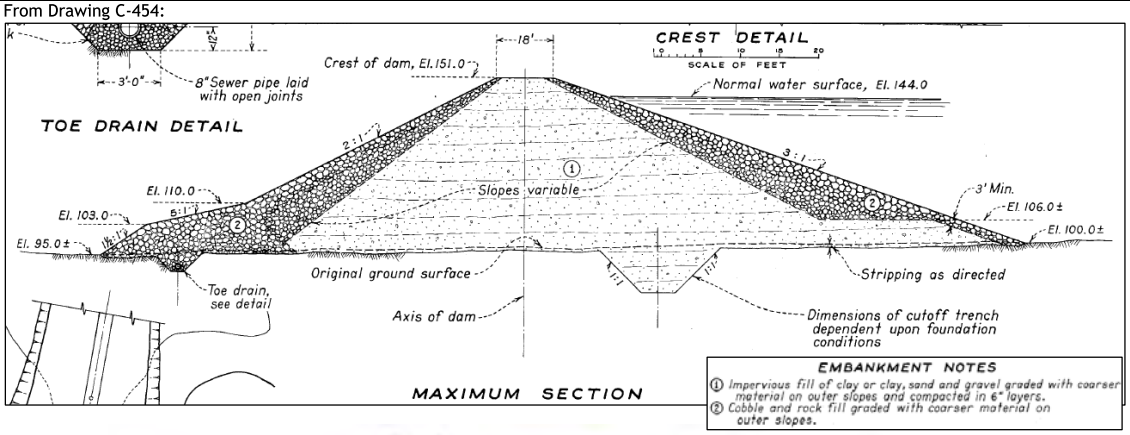
PFM *Confidence* Decision: Key Factor Summary Statement (list of possible further analysis or information to collect)

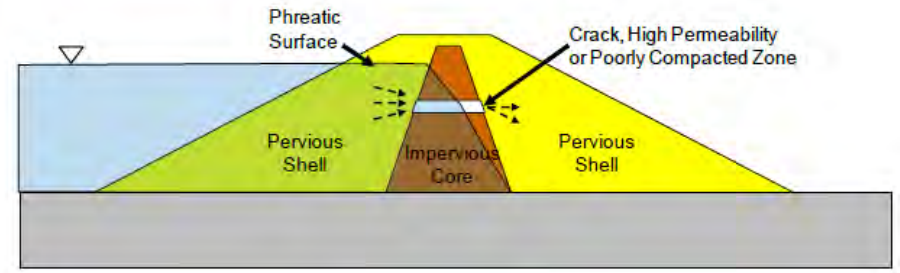
Poor to Medium. The source and cause of observed seepage at the downstream toe is unknown. There is benefit to collecting additional information to increase the confidence in this PFM as a credible failure mode. Additional information may include, but is not limited to:

- Seepage Investigation; attempt to trace and isolate source of seepage
- Geotechnical investigation included drilling, sampling, and soil index testing of Zone 1 material
- Piezometer installation in Zone 1
- Improve seepage collection and monitoring

PFM Sketch

From Drawing C-454:





PFM Event Tree Description

PFM Suite: Internal Erosion through Embankment	
PFM #2	Backward Erosion Piping through Embankment
Initiation: (flaw exists/seepage velocity is high enough to erode material)	• Reservoir level rises to Normal Storage level at Spillway Crest[1]. • A low plasticity layer exists through the Zone 1 embankment core. • Increased seepage develops through the Zone 1 core[2]. • Seepage exit gradient and resulting velocity of flow through the low plasticity layer[2] is sufficient to erode embankment material.
Continuation: (unfiltered exit)	• No effective filter is present to prevent removal of eroded material. • Eroded material exits at interface between Zone 1 core and Zone 2 rock/cobble shell[3].
Progression: (roof/sidewalls support the flaw; no flow limiting; no self-healing)	• Erosion progresses, embankment materials are capable of holding a roof. • No *features are present to restrict flow*[4] through the *defect*[2], which allows the defect to enlarge. • There is no *self-healing material*[5] in the upstream portion of the seepage path. • Erosion pipe forms and progresses toward the upstream face, eventually reaching the reservoir.
Intervention:	• Developing failure mode is not detected, or if detected, intervention is unsuccessful.
Breach:	• Flow through the pipe increases, pipe enlarges. • Uncontrolled release of the reservoir occurs due to gross. enlargement of pipe or collapse of crest above pipe sufficient for water to flow over the embankment. • Embankment erodes down to *stream level*[6]. • Downstream consequences result.

[1] Define a threshold reservoir level below which it is judged that there is insufficient head to initiate the internal erosion. Alternatively, define this as the normal annual maximum pool or a flood pool (if flood load is being considered separately).

[2] Define the defect as specifically as possible. Example defects that may initiate Backward Erosion Piping include:
- a continuous, low plasticity (PI<7) layer or zone through the core, dispersive soil

[3] Indicate proximity of suspected exit location of defect if known.

[4] Flow limiters are natural or manmade, non-erodible features within an embankment that would prevent gross enlargement of a developing pipe, such as a cutoff wall.

[5] Specify any self-healing characteristic or feature, if present, that would need to be ineffective. Crackstopper zones in embankments may be an engineered cohesionless, filter-like material upstream of the core, or a granular upstream shell that is fine-grained enough to flow into pipe. Self-healing can also occur due to filter gradation of eroding material relative to gradation of filtering material (see "some erosion" boundary per Foster and Fell, 2001) or size of defect.

5 The bottom of the breach may be different from stream level depending on particular circumstances; adjust as necessary.

PFM #2 Internal Erosion through Embankment Factors

Event Tree Node	Adverse Factors (PFM More Likely to Occur)	Positive Factors (PFM Less Likely to Occur)
Initiation	• Reservoir fills annually to normal storage level at crest of emergency spillway. • Seepage flow observed at downstream toe • Zone 1 material described in C-454 as "impervious fill of clay or clay, sand and gravel" could potentially have layer of low plasticity soil. •	• Full storage historically not held for long period (possibly not long enough for steady state phreatic surface to develop). • The intent of Zone 1 construction was "impervious fill". • Seepage always observed clear.
Continuation	• No filter incorporated into original design.	• Zone 2 could be filter compatible with Zone 1 core.
Progression	• Zone 1 on upstream slope difficult to inspect for sinkholes and seepage entry points (because overlain by Zone 2). • Unknown if Zone 1 could support a roof (soil classification, PI, etc.) • Unknown thickness and gradation of Zone 2.	• Zone 2 could potentially be flow limiting. •
Intervention	• Dam is remote; no continuous monitoring	• Public access • City of Grand Junction routine inspections.
Breach	• Breach occurs.	• Zone 2 shells could potentially prevent full breach of dam

b. PFM #7: Contact Erosion through Foundation

PFM Worksheet Template				
PFM #	7	**PFM Name**	Contact Erosion through Foundation	
PFM Executive Summary				
PFM Likelihood	Moderate	Likelihood Definition	PFM Date	06 February 2018
Confidence	Poor to Medium	Confidence Definition	PFM Participants	City of Grand Junction Colorado Dam Safety
Consequences	Level 2 or 3	Consequence Definition		

PFM *Likelihood* Decision: Key Factor Summary Statement

The key adverse factors of observed seepage at the downstream toe and lack of embankment soils and construction record lead the team to a likelihood of Moderate.

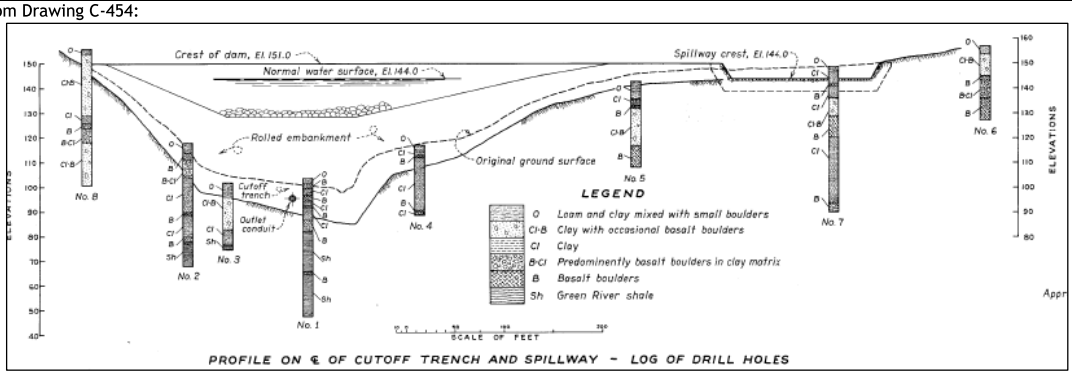
PFM *Confidence* Decision: Key Factor Summary Statement (list of possible further analysis or information to collect)

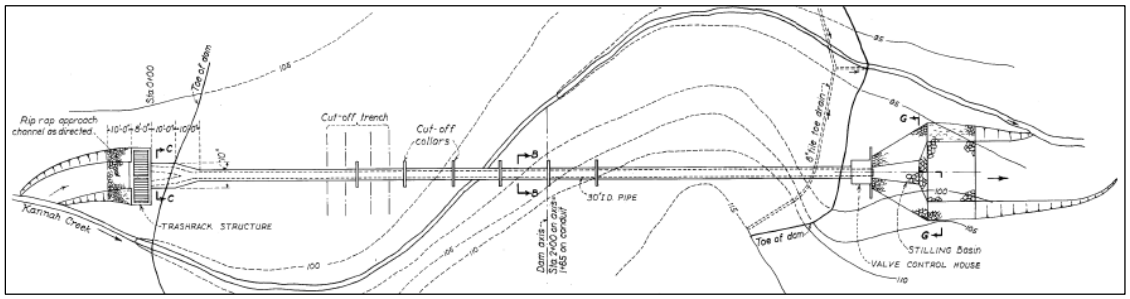
Poor to Medium. The source and cause of observed seepage at the downstream toe is unknown. There is benefit to collecting additional information to increase the confidence in this as a credible failure mode. Additional information may include, but is not limited to:

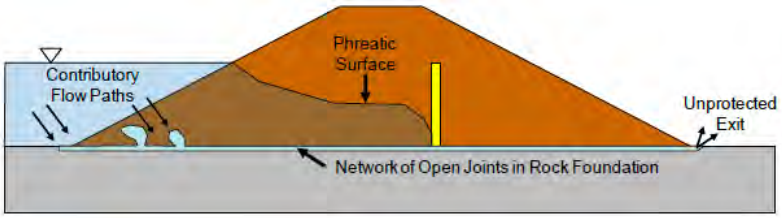
- Seepage Investigation; attempt to trace and isolate source of seepage
- Geotechnical investigation included drilling, sampling, and soil index testing of Zone 1 material
  - Include foundation depth drilling and sampling for this PFM
- Piezometer installation in Zone 1
- Improve seepage collection and monitoring

PFM Sketch

From Drawing C-454:







PFM Event Tree Description

PFM Suite: Internal Erosion through Foundation	
PFM # 7	**Contact Erosion through Foundation**
Initiation: (flaw exists/seepage velocity is high enough to erode material)	• Reservoir level rises to Normal Storage level at Spillway Crest[1]. • *A defect*[2] exists through the foundation: A zone of pervious foundation underlying Zone 1 embankment material • Contact erosion develops *through/along* the *defect*[2]. • Seepage gradient *through/along* the *defect*[2] is sufficient to erode adjacent foundation material, given the *direction*[3] of the exiting seepage. Seepage is believed to exit horizontally at the downstream toe.
Continuation: (unfiltered exit)	• No effective filter is present to prevent removal of eroded material. • Eroded material exits at the downstream toe *behind the outlet headwall and from the right abutment*[4].
Progression: (roof/sidewalls support the flaw; no flow limiting; no self-healing)	• Erosion progresses, *foundation*[5] materials are capable of holding a roof. • No *features are present to restrict flow*[6] through the *defect*[2], which allows the defect to enlarge.

	• There is no *self-healing material*[7] in the upstream portion of the scour/seepage path. • Erosion pipe forms and progresses toward the upstream face, eventually reaching the reservoir.
Intervention:	• Developing failure mode is not detected, or if detected, intervention is unsuccessful.
Breach:	• Flow through the pipe increases, pipe enlarges. • Embankment breaches due to gross enlargement of pipe or collapse of crest above pipe sufficient for water to flow over the embankment. • Embankment erodes down to *stream level*[8]. • Downstream consequences result.

[1] Define a threshold reservoir level below which it is judged that there is insufficient head to initiate the internal erosion. Alternatively, define this as the normal annual maximum pool or a flood pool (if flood load is being considered separately).
[2] Define the defect as specifically as possible. A defect may be a series or combination of several conditions required for initiation. Example defects that may initiate Contact Erosion include:
- Flow through pervious foundation layer underlying fine-grained confining layer
- Pervious foundation seepage path may be a system of high-porosity interconnected and open rock fractures, solution cavities, shallow open coarse material, or a fault system

[3] Consider whether the exit is vertical/up or horizontally out. It is easier to erode from a horizontal exit.
[4] Indicate proximity of suspected exit location of defect if known. Exit may be significantly downstream of dam
[5] Adjust roof supporting material as appropriate. May be a hard or cohesive foundation layer, overlying embankment, concrete slab beneath a structure, etc.
[6] Flow limiters are natural or manmade, non-erodible features within the foundation that would prevent gross enlargement of a developing pipe, such as a cutoff wall, bedrock or hardpan features, size of fractures, etc.
[7] Specify any self-healing characteristic or feature, if present, that would need to be ineffective. Crackstopper zones in foundation may be an engineered cohesionless, filter-like material overlying the foundation (upstream of core), or a granular upstream shell that is fine-grained enough to flow into pipe. Self-healing can also occur due to filter gradation of eroding material relative to gradation of filtering material or size of defect.
[8] The bottom of the breach may be different from stream level depending on particular circumstances; adjust as necessary.

PFM #7 Contact Erosion through Foundation Factors

Event Tree Node	Adverse Factors (PFM More Likely to Occur)	Positive Factors (PFM Less Likely to Occur)
Initiation	• Reservoir fills annually to normal storage level at crest of emergency spillway. • Seepage flow observed at downstream toe • Foundation drill logs in C-454 show possible pervious layers (Predominantly basalt boulders in clay matrix, B-Cl, for instance) • Original stream channel meanders through foundation • Horizontal gradient *is sufficient* to erode adjacent material? ○ Avg gradient, i = 45/300 = 0.15	• Full storage historically not held for long period (not long enough for steady state phreatic surface to develop). • The intent of Zone 1 construction was "impervious fill". • Seepage always observed clear • Construction Specifications for foundation preparation (although generally generic) • Cut-off trench could cutoff or lengthen seepage path • Horizontal gradient *is not sufficient* to erode adjacent material?
Continuation	• No filter incorporated into original design.	• Zone 2 shell could be filter compatible Zone 1 core? • Toe drain exists at downstream toe
Progression	• Zone 1 on upstream slope difficult to inspect for sinkholes and seepage entry points. • Unknown thickness and gradation of Zone 2. • Unknown if Zone 1 could support a roof (soil classification, PI, etc.)	• Zone 2 likely flow limiting. •
Intervention	• Dam is remote; no continuous monitoring	• Public access • City of Grand Junction routine inspections.
Breach	• Breach occurs.	• Zone 2 shells could potentially prevent full breach of dam

c. *PFM #12: Internal Erosion Along the Conduit*

PFM Worksheet Template				
PFM #	12	**PFM Name**	Internal Erosion *Along* the Conduit	
PFM Executive Summary				
PFM Likelihood	High	Likelihood Definition	PFM Date	06 February 2018
Confidence	Poor	Confidence Definition	PFM Participants	City of Grand Junction Colorado Dam Safety
Consequences	Level 2	Consequence Definition		

PFM *Likelihood* Decision: Key Factor Summary Statement

The key adverse factors of observed seepage at the downstream toe and known potential defects around embedded conduit without the benefit of a filtered seepage exit lead the team to a likelihood of High.

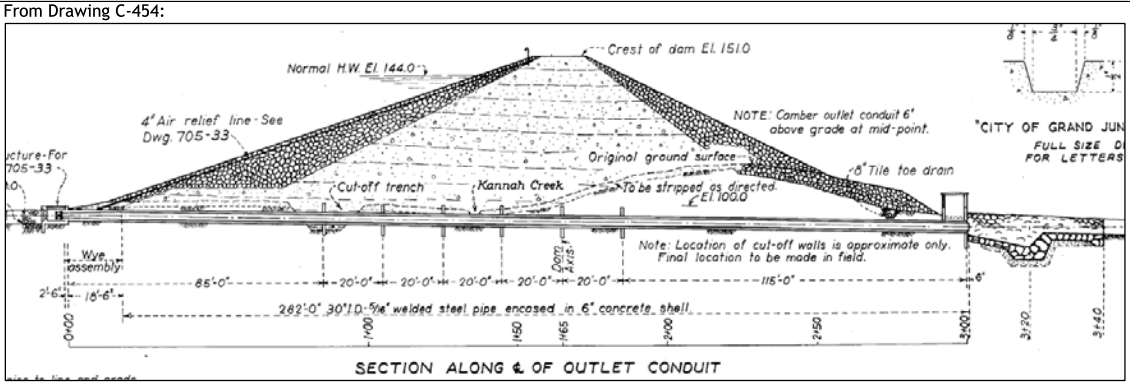
PFM *Confidence* Decision: Key Factor Summary Statement (list of possible further analysis or information to collect)

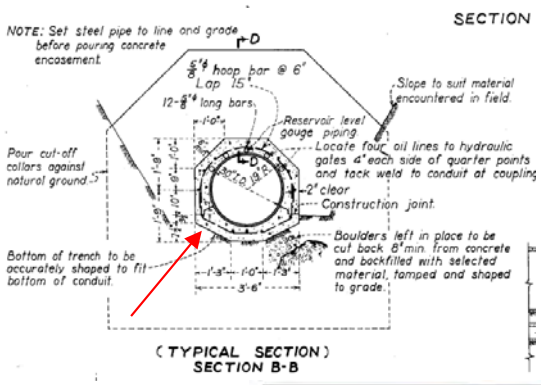
Poor. The source and cause of observed seepage at the downstream toe is unknown. There is benefit to collecting additional information to increase the confidence in this as a credible failure mode. Additional information may include, but is not limited to:

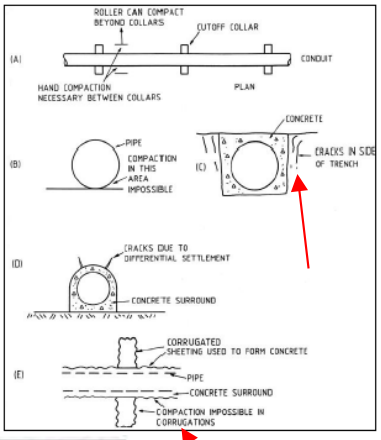
- Seepage Investigation; attempt to trace and isolate source of seepage
- Geotechnical investigation included drilling, sampling, and soil index testing of Zone 1 material
- Piezometer installation in Zone 1
- Improve seepage collection and monitoring

PFM Sketch

From Drawing C-454:







PFM Event Tree Description

PFM Title: Internal Erosion Along the Conduit	
PFM #12	Concentrated Leak Erosion or Backward Erosion Piping Along Conduit
Initiation: (flaw exists/seepage velocity is high enough to erode material)	• Reservoir level rises Normal Storage level at Spillway Crest[1]. • The initial construction of the dam resulted in a *defect*[2] in the backfill along the entire length (i.e., continuous) of the contact with the outlet conduit leading to *concentrated leak erosion*[3] along the conduit. • Seepage gradient and resulting velocity of flow is sufficient to erode backfill material along the conduit.
Continuation: (unfiltered exit)	• No effective filter is present at the seepage exit to prevent removal of eroded material. • Eroded material exits at the downstream toe *behind the outlet headwall and from the right abutment*[4].
Progression:	• Erosion progresses, embankment materials are capable of holding a roof.

	(roof/sidewalls support the flaw; no flow limiting; no self-healing)	• No *features are present to restrict flow*[5] along the conduit, which allows the seepage path to enlarge. • There is no *self-healing material*[6] in the upstream portion of the seepage path. • Erosion pipe forms and progresses toward the upstream face, eventually reaching the reservoir.
	Intervention:	• Developing failure mode is not detected, or if detected, intervention is unsuccessful.
	Breach:	• Flow through the pipe increases, pipe enlarges. • Uncontrolled release of the reservoir occurs due to gross enlargement of pipe or collapse of crest above pipe sufficient for water to flow over the embankment. • Embankment erodes down to *stream level*[7]. • Downstream consequences result.

[1] Define a threshold reservoir level below which it is judged that there is insufficient head to initiate the internal erosion. Alternatively, define this as the normal annual maximum pool or a flood pool (if flood load is being considered separately).
[2] Examples of a defect along a conduit include a crack, void, or zone of low compaction density due to shape of conduit or presence and configuration of seepage collars (CONCENTRATED LEAK EROSION).
[3] This could in some cases be considered BACKWARD EROSION PIPING if there is a continuous zone of low plasticity, cohesionless, erodible soils/backfill along the conduit that is loose because of the above-described potential defects.
[4] Consider configuration of exit of seepage along a conduit. Open exit, horizontal/vertical exit, heave or blowout required?
[5] Flow limiters are natural or manmade, non-erodible features within the embankment or foundation that would prevent gross enlargement of a developing pipe, such as a cutoff wall, bedrock or hardpan features, grout curtain, size of fractures, etc.
[6] Specify any self-healing characteristic or feature, if present, that would need to be ineffective. Crackstopper zones in embankments may be an engineered cohesionless, filter-like material upstream of the core, or a granular upstream shell that is fine-grained enough to flow into pipe. Self-healing can also occur due to filter gradation of eroding material relative to size of defect.
[7] The bottom of the breach may be different from stream level depending on particular circumstances; adjust as necessary.

PFM #12 Internal Erosion Along Conduit Factors

Event Tree Node	Adverse Factors (PFM More Likely to Occur)	Positive Factors (PFM Less Likely to Occur)
Initiation	• Reservoir fills annually to normal storage level at crest of emergency spillway. • Seepage flow observed at downstream toe • Potentially poor compaction around cutoff collars (see red arrows above) • Trench excavation low stress zones (see red arrows above) • Unique shape of conduit concrete encasement (poor compaction, low stress/compaction zones) •	• Full storage historically not held for long period (not long enough for steady state phreatic surface to develop). • Intent of construction drawings and specifications was to cutoff seepage with cutoff collars • Seepage always observed clear
Continuation	• No filter incorporated into original design.	• Zone 2 shell could be filter compatible Zone 1 core?
Progression	• Zone 1 on upstream slope difficult to inspect for sinkholes and seepage entry points. • Unknown if Zone 1 could support a roof (soil classification, PI, etc.)	• Zone 2 likely flow limiting
Intervention	• Dam is remote; no continuous monitoring	• Public access • City of Grand Junction routine inspections.
Breach	• Breach occurs. Full breach of dam likely associated with this PFM.	•

d. PFM #13: Internal Erosion Into the Conduit

PFM Worksheet Template				
PFM #	13	**PFM Name**	Internal Erosion *Into* the Conduit	
PFM Executive Summary				
PFM Likelihood	Moderate	Likelihood Definition	PFM Date	06 February 2018
Confidence	Medium to Strong	Confidence Definition	PFM Participants	City of Grand Junction Colorado Dam Safety
Consequences	Level 2	Consequence Definition		

PFM *Likelihood* Decision: Key Factor Summary Statement

The key adverse factors of suspected/known air vent open joint discharging into the outlet conduit lead the team to a likelihood of Moderate: the fundamental condition or defect exists and the failure mode is plausible.

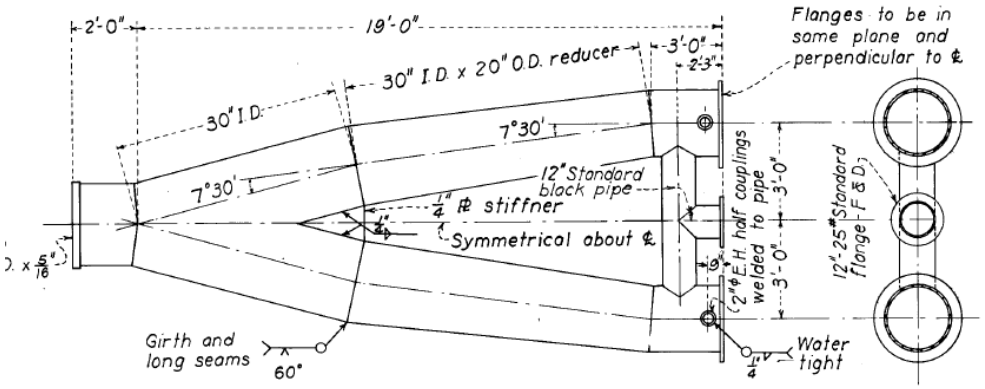
PFM *Confidence* Decision: Key Factor Summary Statement (list of possible further analysis or information to collect)

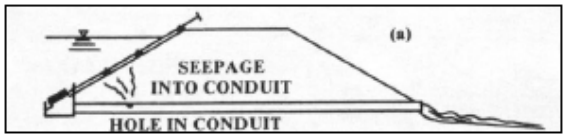
Medium to Strong. The source and cause of observed seepage at the downstream toe is unknown. There is benefit to collecting additional information to increase the confidence in this as a credible failure mode. Additional information may include, but is not limited to:

- Drain the reservoir to investigate the air vent connection(s)
- Perform internal inspection of the outlet to confirm condition
  - With storage to confirm leakage into/out of conduit
  - Without storage to observe dewatered dry conduit

PFM Sketch

From Drawing C-454:





PFM Event Tree Description

PFM #13	PFM Title: Internal Erosion Into the Conduit[1]
Initiation: (flaw exists/seepage velocity is high enough to erode material)	• Reservoir level rises Normal Storage level at Spillway Crest[1]. • The *conduit*[1] has a *defect*[3]: Suspected/known air vent open joint. • Seepage gradient and resulting velocity of flow is sufficient to initiate *scour or backward erosion piping*[4] of the embankment material into the conduit.
Continuation: (unfiltered exit)	• No effective filter is present along the seepage path to prevent removal of eroded material.[5] • Eroded material exits *into the conduit and transported to outlet channel.*[6].
Progression: (roof/sidewalls support the flaw; no flow limiting; no self-healing)	• Erosion progresses upstream, embankment materials are capable of holding a roof. • No *features are present to restrict flow*[7] which allows the seepage path to enlarge. • There is no *self-healing material*[8] in the upstream portion of the seepage path. • Erosion pipe forms and progresses toward the upstream face[9], eventually reaching the reservoir.
Intervention:	• Developing failure mode is not detected, or if detected, intervention is unsuccessful.
Breach:	• Flow through the erosion pipe increases, pipe enlarges. • Uncontrolled release of the reservoir occurs due to gross enlargement of erosion pipe or collapse of crest above erosion pipe sufficient for water to flow over the embankment. • Embankment erodes down to *stream level*[10]. • Downstream consequences result.

[1] Specify whether PFM is for erosion into an outlet conduit or drain pipe.
[2] Define a threshold reservoir level below which it is judged that there is insufficient head to initiate the internal erosion. Alternatively, define this as the normal annual maximum pool or a flood pool (if flood load is being considered separately).
[3] Examples of a defect along a conduit include a crack or open pipe joint. Examples of a defect along a drain include slots/perforations cut too large for surrounding soil, collapsed pipe, rusted holes, or open joints. Defect occurs at a location below the phreatic surface.
[4] Depending on the characteristics of the embankment material the erosion mechanism may either be backward erosion (for low plasticity, PI<7, soils) or scour for more plastic soils.

[5] Seepage into a conduit is rarely filtered; however, drain (perforated or slotted) pipes are usually constructed in a filter envelope.
[6] State location where seepage and eroded material may exit (within an impact basin, toe drain weir box, manhole/inspection well, or daylight exit [e.g. within a flowline]).
[7] Flow limiters are natural or manmade, non-erodible features within the embankment or foundation that would prevent gross enlargement of a developing pipe, such as a cutoff wall, bedrock or hardpan features, grout curtain, size of fractures, etc.
[8] Specify any self-healing characteristic or feature, if present, that would need to be ineffective. Crackstopper zones in embankments may be an engineered cohesionless, filter-like material upstream of the core, or a granular upstream shell that is fine-grained enough to flow into pipe. Self-healing can also occur due to filter gradation of eroding material relative to size of defect.
[9] Stoping (vertical erosion) may occur above the conduit/drain eventually creating a sinkhole in the downstream slope. For loss of reservoir, this PFM only considers erosion that progresses upstream intercepting the reservoir.
[10] The bottom of the breach may be different from stream level depending on particular circumstances; adjust as necessary.

PFM #13 Internal Erosion Into Conduit Factors

Event Tree Node	Adverse Factors (PFM More Likely to Occur)	Positive Factors (PFM Less Likely to Occur)
Initiation	• Reservoir fills annually to normal storage level at crest of emergency spillway. • Known air vent leakage into conduit from 2008 internal inspection video • High gradient (full head) and contact with embankment Zone 1?	• Full storage historically not held for long period. • No other known defects in conduit • Conduit is encased in concrete • 2008 Video inspection shows otherwise (other than air vent) acceptable condition of conduit • High gradient (full head), but limited embankment coverage of air vent defect?
Continuation	• Contact with Zone 1 material?	• Little to no contact with Zone 1 material?
Progression	• Zone 1 on upstream slope difficult to inspect for sinkholes and seepage entry points.	• Air vent diameter (2-inches) flow limiting/restriction.
Intervention	• Dam is remote; no continuous monitoring	• Public access • City of Grand Junction routine inspections.
Breach	• Breach occurs. Full breach of dam likely associated with this PFM?	•

e. PFM #15: Overtopping

PFM Worksheet Template				
PFM #	15	**PFM Name**	Overtopping	
PFM Executive Summary				
PFM Likelihood	High	Likelihood Definition	PFM Date	06 February 2018
Confidence	Poor	Confidence Definition	PFM Participants	City of Grand Junction Colorado Dam Safety
Consequences	Level 2 or 3	Consequence Definition		

PFM *Likelihood* Decision: Key Factor Summary Statement

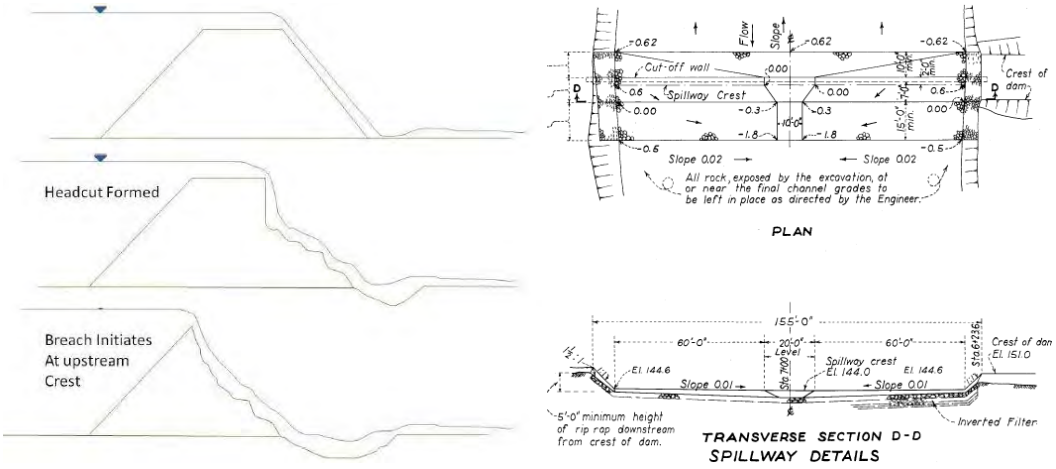
The key adverse factors of unknown inflow design flood (IDF) and spillway adequacy lead the team to a likelihood of High.

PFM *Confidence* Decision: Key Factor Summary Statement (list of possible further analysis or information to collect)

Poor. Benefit of performing a hydrology study to determine IDF and spillway adequacy.

PFM Sketch

From Drawing C-454:



PFM Event Tree Description

PFM #15	PFM Title: Overtopping
Initiation:	• A flood up to and including the Inflow Design Flood[1] occurs. • Reservoir level rises to the *Spillway crest elevation 144.0 (per C-454)*[2]. • The *spillway capacity is exceeded*[3] and reservoir level rises to *Elevation 151 (per C-454)*[4] initiating overtopping of the *embankment/abutment*. • Overflow duration, depth, and velocity cause erosion of the *downstream face/abutment* of the dam.
Continuation:	• The downstream portion of the dam is eroded by head-cutting from the downstream toe.
Progression:	• The duration of the flow is long enough to permit the erosion to progress upstream eventually eroding the crest.
Intervention:	• The overtopping is not observed; or if detected, methods to stop the overtopping and erosion are not deployed in time and as a result, intervention is unsuccessful.
Breach:	• Down-cutting of the embankment crest leads to breach by widening and deepening of the head-cut channel in the dam. • Embankment erodes down to *stream level*[5]. • Downstream consequences result.

[1] State what flood event is taken as the inflow design flood.
[2] Define spillway crest elevation. This may be a gated spillway or uncontrolled overflow.
[3] Example causes for exceeding spillway capacity include undersized spillway, debris blockage, misoperation, or failure of a gate hoist/chain/valve. Different PFMs may be warranted for different spillway capacity defects.
[4] Define lowest elevation at which point overtopping of the erodible portion of the embankment or abutment would occur.
[5] The bottom of the breach may be different from stream level depending on particular circumstances; adjust as necessary.

PFM #15 Overtopping Factors

Event Tree Node	Adverse Factors (PFM More Likely to Occur)	Positive Factors (PFM Less Likely to Occur)
Initiation	• Reservoir fills annually to normal storage level at crest of emergency spillway. • No known hydrology study; so IDF and spillway adequacy unknown.	• No evidence of full spillway flow in history of dam
Continuation	• Unknown thickness/gradation of Zone 2 • Is dam crest level in the event of overtopping?	• Armored Zone 2 downstream slope
Progression	•	•

Intervention	• Dam is remote and overtopping may not be observed.	• Public access • City of Grand Junction routine inspections. • Routine NWS storm tracking nearby
Breach	• Breach occurs.	• Zone 2 shells could potentially prevent full breach of dam

f. PFM #26: Outlet Gate(s) Fail to Open

PFM Worksheet Template				
PFM #	26	**PFM Name**	Outlet Gate(s) Fail to Open	
PFM Executive Summary				
PFM Likelihood	High	Likelihood Definition	PFM Date	06 February 2018
Confidence	Medium to Strong	Confidence Definition	PFM Participants	City of Grand Junction Colorado Dam Safety
Consequences	Level 2 or 3	Consequence Definition		

PFM *Likelihood* Decision: Key Factor Summary Statement

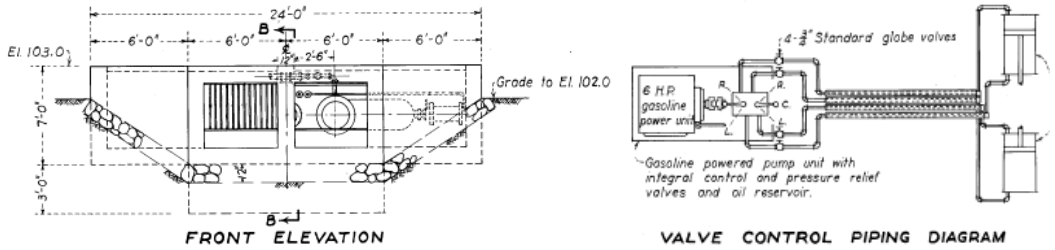
The key adverse factors of known concerns with reliability of the outlet gate(s) hydraulic controls and the potential for other PFMs to initiate with the inability to withdraw the reservoir lead the team to a likelihood of High.

PFM *Confidence* Decision: Key Factor Summary Statement (list of possible further analysis or information to collect)

Medium to Strong. Potential benefit to drain the reservoir and investigate the condition of the hydraulic controls. Decide whether to repair or replace.

PFM Sketch

From Drawing C-454:



PFM Event Tree Description

PFM #25	PFM Title: Outlet Gate(s) Fail to Close
Initiation:	• Reservoir level rises to the *Spillway crest elevation*. • The outlet gates fail to open. • Other PFMs are initiated with reservoir at this elevation
Continuation:	• Repair of hydraulic operator in unsuccessful. • Attempt to manually open the outlet gates is unsuccessful. • Other PFMs continue.
Progression:	• Reservoir cannot be drawn down through the outlet conduit • Progression of other PFMs cannot be mitigated by drawdown of the reservoir.
Intervention:	• Other means of drawing down the reservoir (pumps, siphons, divers, etc) are unsuccessful so intervention of other PFMs is unsuccessful.
Breach:	• Dam breaches by other PFMs. • Embankment erodes down to *stream level*[5]. • Downstream consequences result.
[1]S	

PFM #26 Outlet Gate(s) Fail to Open Factors

Event Tree Node	Adverse Factors (PFM More Likely to Occur)	Positive Factors (PFM Less Likely to Occur)
Initiation	• Reservoir fills annually to normal storage level at crest of emergency spillway. • Dependence on hydraulic operation; no manual override or operation. • Unable to drawdown reservoir and prevent initiation of other PFMs • Historic concerns with reliable operation of hydraulic controls.	• Redundant valves, so it is possible only one valve fails to open.
Continuation	• No known means to manually open gates.	• Diver could possibly manually operate bypass valve?
Progression	• Other PFMs progress without lowering of reservoir. •	•
Intervention	• Time to mobilize and activate other means is likely slower than progression of other PFMs	• Slowly progressing PFMs could possibly be mitigated with pumping or siphoning of reservoir.
Breach	• Breach occurs.	•

2. Worksheets for Non-Risk Driving PFMs

a. PFM #3: Contact Erosion through Embankment

<*Paste PFM Worksheets that were developed but identified as non-Risk driving as image*>

b. PFM #4: Suffusion/Suffosion through Embankment

<*Paste PFM Worksheets that were developed but identified as non-Risk driving as image*>

c. PFM #14: Concentrated Leak Erosion out of Conduit

<*Paste PFM Worksheets that were developed but identified as non-Risk driving as image*>

d. PFM #18: Reservoir Landslide/Seiche Leading to Overtopping

<*Paste PFM Worksheets that were developed but identified as non-Risk driving as image*>

e. PFM #19: Rise in Phreatic Level Causes Deformations that Exceed Freeboard

<*Paste PFM Worksheets that were developed but identified as non-Risk driving as image*>

f. PFM #20: Slump Reduces Seepage Path Leading to Internal Erosion

<*Paste PFM Worksheets that were developed but identified as non-Risk driving as image*>

g. PFM #21: Rapid Drawdown Failure of Upstream Slope

<*Paste PFM Worksheets that were developed but identified as non-Risk driving as image*>

h. PFM #22: Dynamic Deformation Greater than Freeboard

<*Paste PFM Worksheets that were developed but identified as non-Risk driving as image*>

i. PFM #23: Differential Settlement Leads to Transverse Cracking

Appendix B
Site Orientation Photographs

Photo 1: Site map; 2016 aerial image

Photo 1: View looking upstream at spillway crest, 12/11/2017

Photo 2: Upstream slope; Outlet hydraulics control building at center of dam on upstream edge of dam crest.

Photo 3: Downstream slope; Zone 2 material per C-454

Photo 4: Downstream outlet headwall.

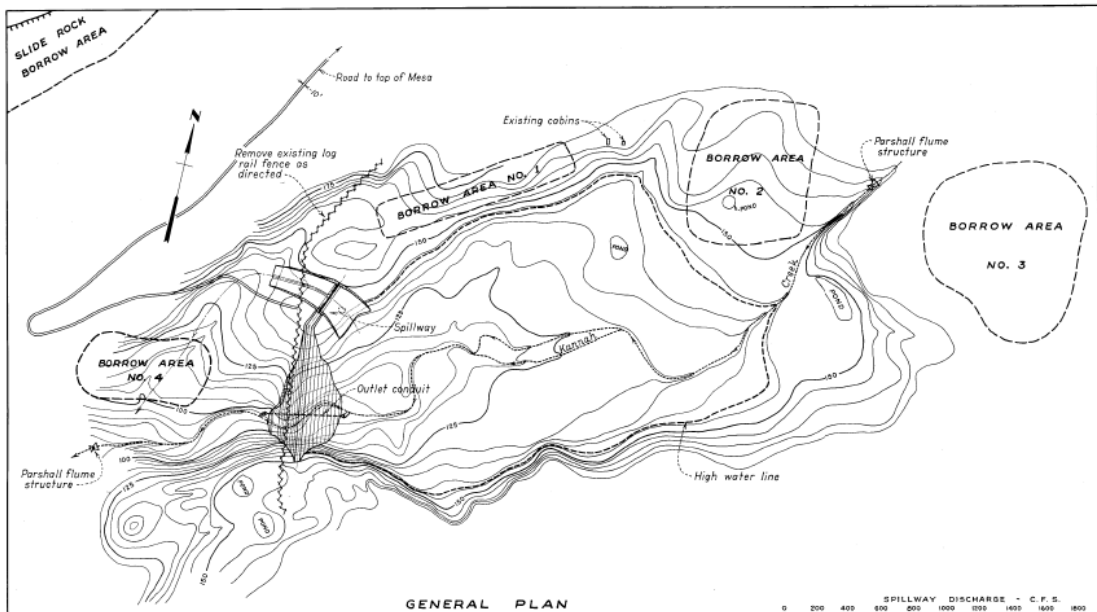
Photo 5: Downstream outlet pipe headwall.

Photo 6: Abandoned outlet hydraulics control building foundation behind headwall.

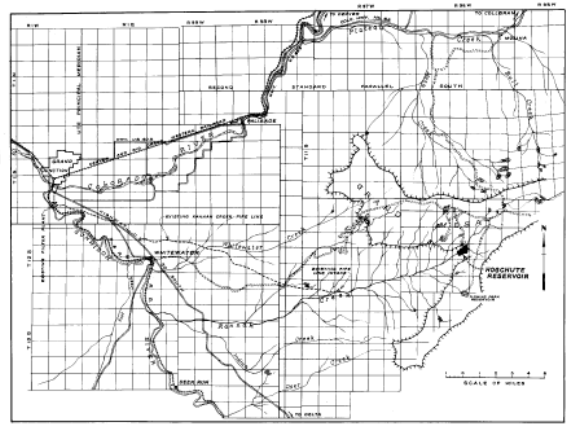
Photo 7: Collection and monitoring pipe from right side of outlet headwall.

Photo 11: Seepage behind right side of outlet headwall.

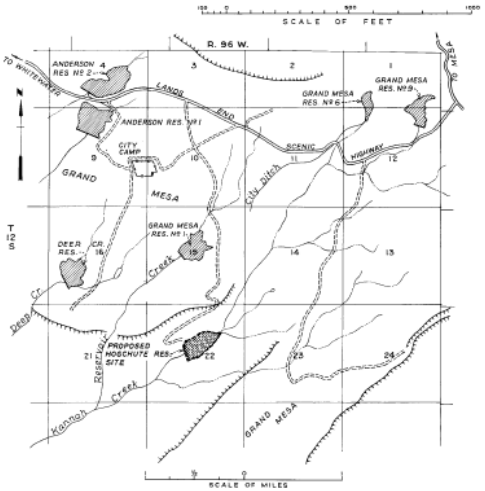
Appendix C
Pertinent Drawings



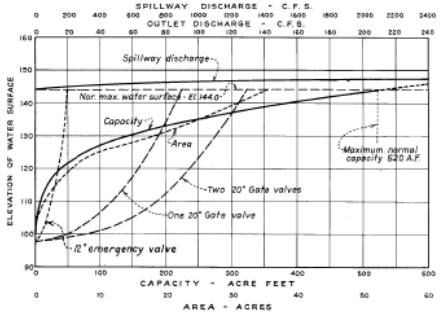
GENERAL PLAN



VICINITY MAP



LOCATION MAP



AREA, CAPACITY AND DISCHARGE CURVES

NOTES

Reservoir site is entirely within the limits of the Grand Mesa National Forest. All clearing operations, cutting and disposal of timber, shall be performed in accordance with rules and regulations prescribed by the Forest Supervisor.

Altitude of reservoir site is approximately elevation 9250

REFERENCE DRAWINGS

VICINITY MAP AND GENERAL PLAN	705-30
PLAN, PROFILE AND SECTIONS	705-31
OUTLET WORKS - VALVE CONTROL HOUSE	705-32
TRASHRACK STRUCTURE AND SPILLWAY DETAILS	705-33
PARSHALL FLUME - PLAN, SECTIONS AND DETAILS	705-34

Approved on the 24 day of May 1947

By R. J. Tipton
STATE ENGINEER

By
DEPUTY

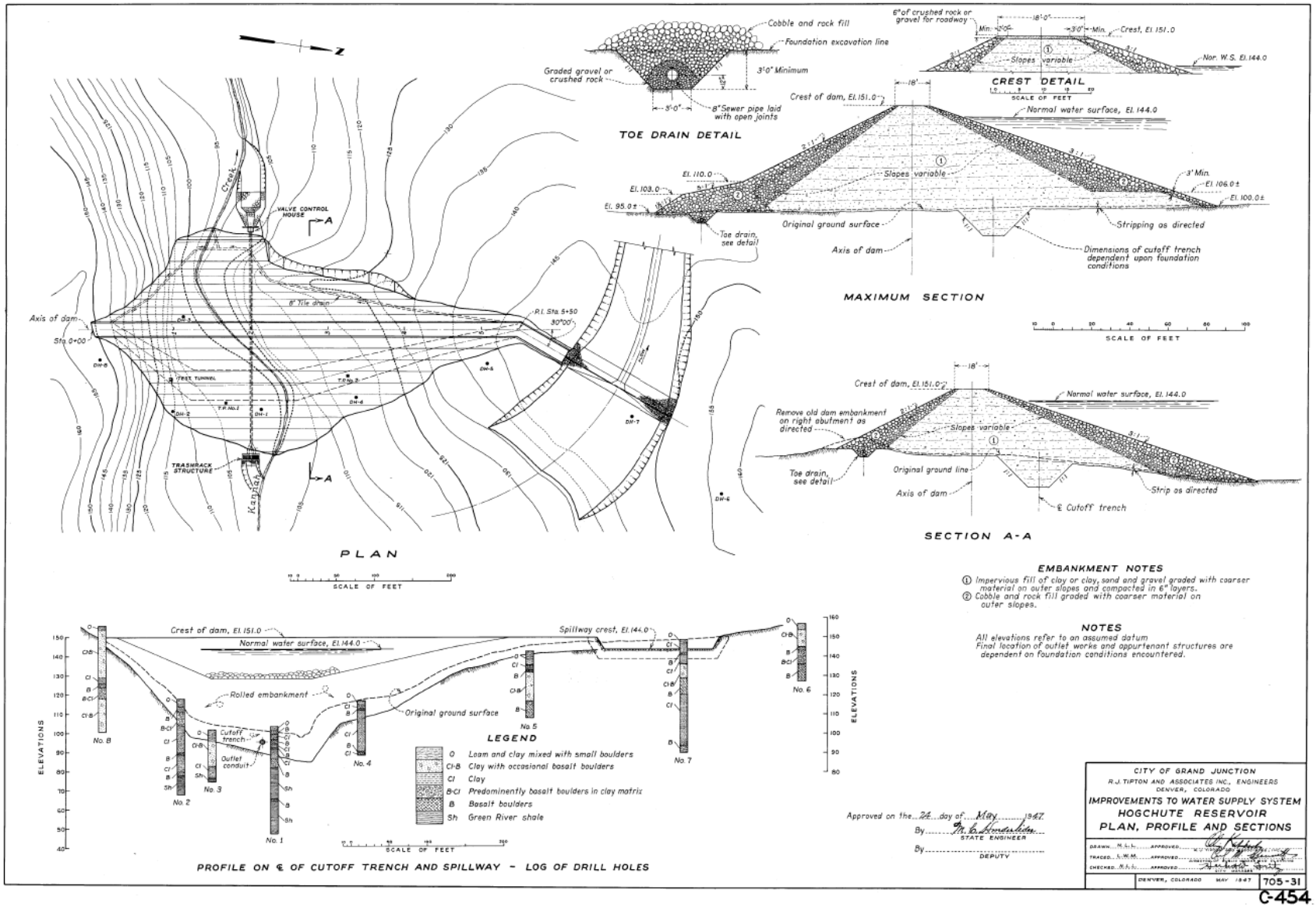
CITY OF GRAND JUNCTION
R.J. TIPTON AND ASSOCIATES INC., ENGINEERS
DENVER, COLORADO

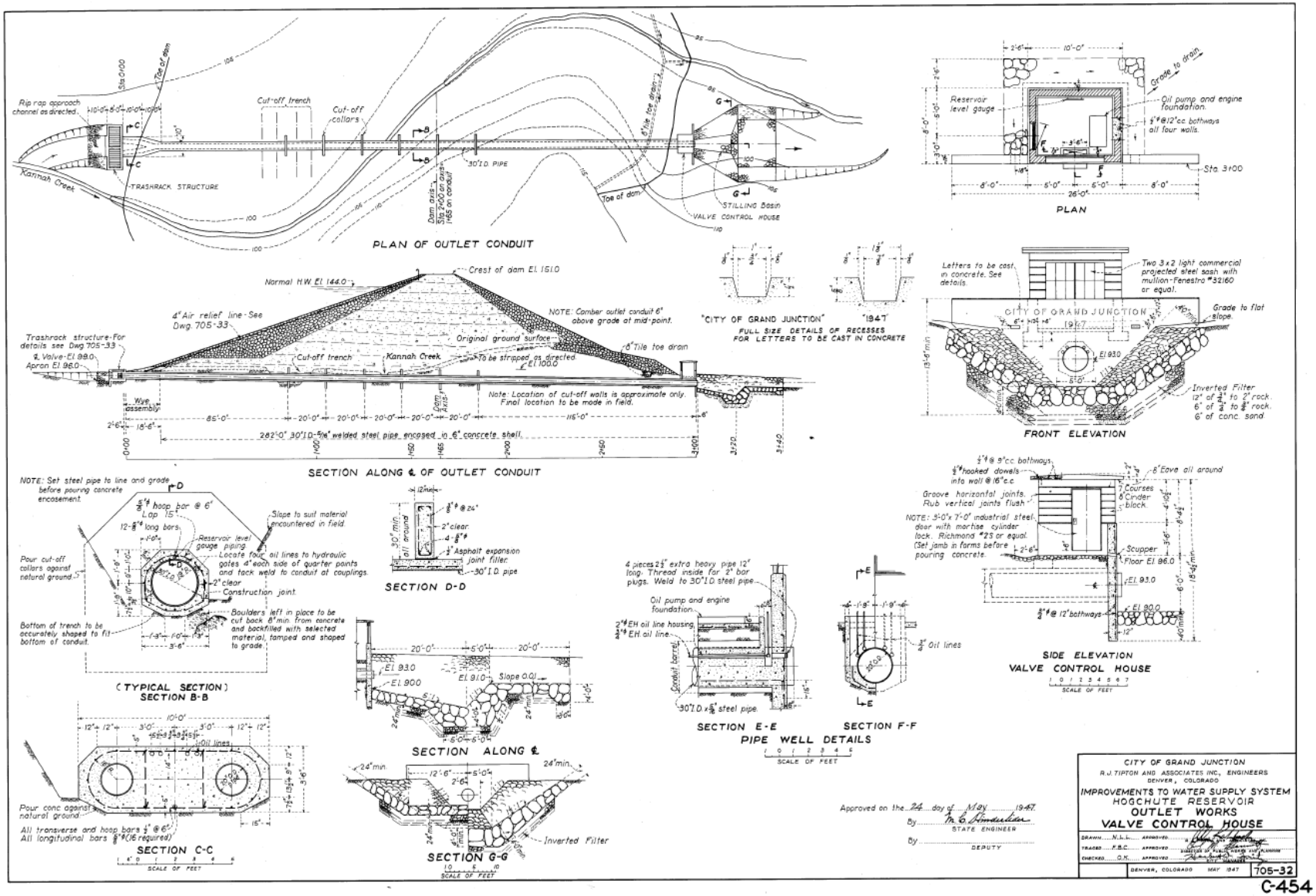
IMPROVEMENTS TO WATER SUPPLY SYSTEM
HOGCHUTE RESERVOIR
VICINITY MAP AND GENERAL PLAN

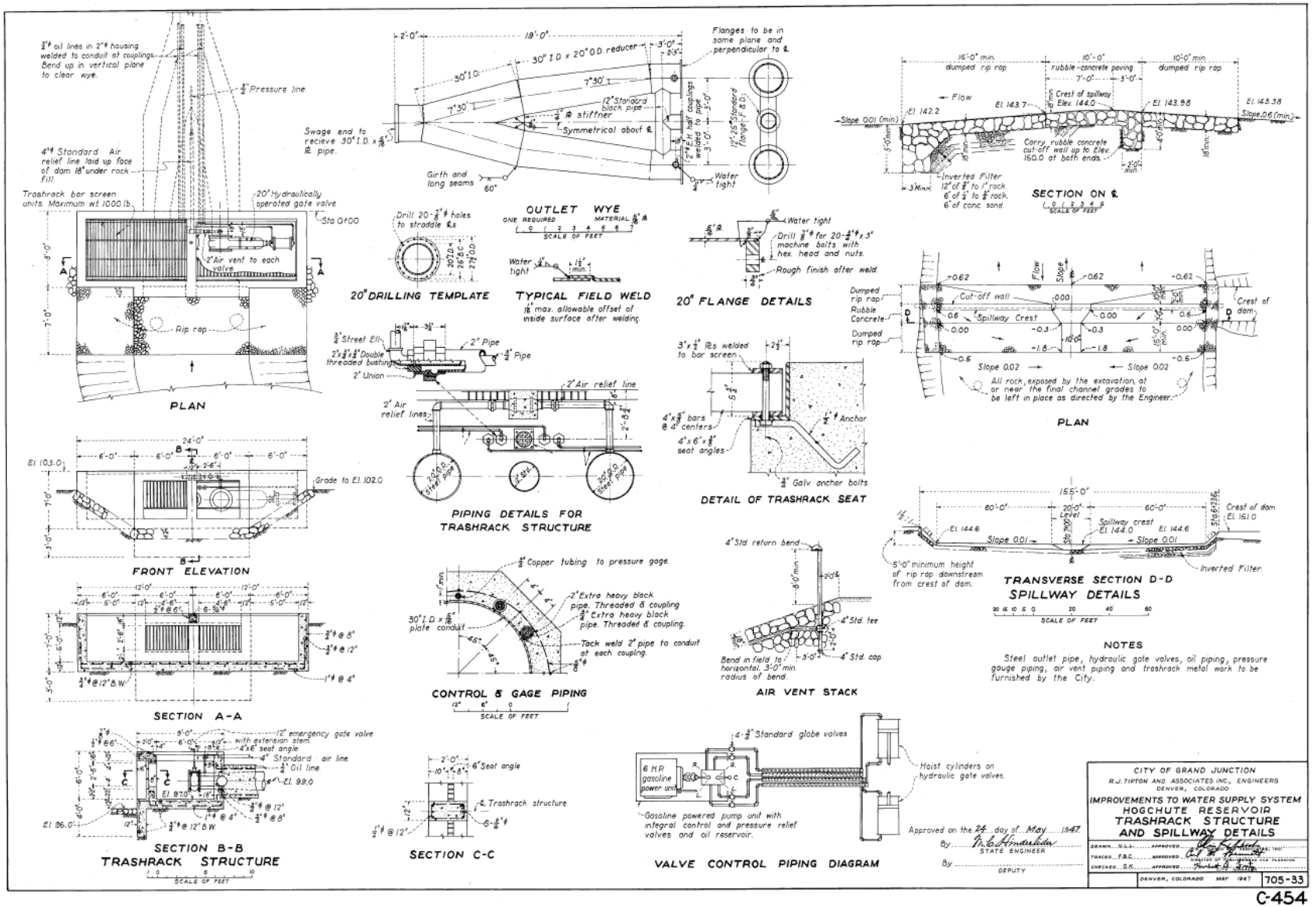
DRAWN M.L.L. APPROVED
TRACED A.W.M. APPROVED
CHECKED M.L.L. APPROVED

DENVER, COLORADO MAY 1947 705-30

C-454


Cobble and rock fill
Foundation excavation line
Graded gravel or crushed rock
3'0" Minimum
8" Sewer pipe laid with open joints
TOE DRAIN DETAIL
6" of crushed rock or gravel for roadway
Crest, El. 151.0
Slopes variable
Nor. W.S. El. 144.0
CREST DETAIL
SCALE OF FEET
Crest of dam, El. 151.0
Normal water surface, El. 144.0
El. 110.0
El. 103.0
El. 95.0±
Toe drain, see detail
Original ground surface
Axis of dam
Stripping as directed
El. 106.0±
El. 100.0±
Dimensions of cutoff trench dependent upon foundation conditions
MAXIMUM SECTION
Remove old dam embankment on right abutment as directed
Strip as directed
℄ Cutoff trench
SECTION A-A
Creek
VALVE CONTROL HOUSE
6" Tile drain
P.I. Sta. 5+50
30°00'
Axis of dam
Sta. 0+00
TRASHRACK STRUCTURE
TUNNEL
PLAN
Crest of dam, El. 151.0
Normal water surface, El. 144.0
Spillway crest, El. 144.0
Rolled embankment
Original ground surface
Cutoff trench
Outlet conduit
No. 1
No. 2
No. 3
No. 4
No. 5
No. 6
No. 7
No. 8
ELEVATIONS
LEGEND
O Loam and clay mixed with small boulders
Cl-B Clay with occasional basalt boulders
Cl Clay
B-Cl Predominently basalt boulders in clay matrix
B Basalt boulders
Sh Green River shale
PROFILE ON ℄ OF CUTOFF TRENCH AND SPILLWAY - LOG OF DRILL HOLES
EMBANKMENT NOTES
① Impervious fill of clay or clay, sand and gravel graded with coarser material on outer slopes and compacted in 6" layers.
② Cobble and rock fill graded with coarser material on outer slopes.
NOTES
All elevations refer to an assumed datum
Final location of outlet works and appurtenant structures are dependent on foundation conditions encountered.
Approved on the 24 day of May 1947
By STATE ENGINEER
By DEPUTY
CITY OF GRAND JUNCTION
R.J. TIPTON AND ASSOCIATES INC., ENGINEERS
DENVER, COLORADO
IMPROVEMENTS TO WATER SUPPLY SYSTEM
HOGCHUTE RESERVOIR
PLAN, PROFILE AND SECTIONS
DENVER, COLORADO MAY 1947
705-31
C-454


PLAN OF OUTLET CONDUIT
Rip rap approach channel as directed.
Sta 0+00
Toe of dam
Cut-off trench
Cut-off collars
Kannah Creek
TRASHRACK STRUCTURE
30" I.D. PIPE
Dam axis - Sta 2+00 on dam 1+65 on conduit
6" tile toe drain
Toe of dam
STILLING Basin
VALVE CONTROL HOUSE
Normal H.W. El 144.0
Crest of dam El. 151.0
4" Air relief line - See Dwg. 705-33
NOTE: Camber outlet conduit 6" above grade at mid-point.
Trashrack structure-For details see Dwg 705-33
Original ground surface
6" Tile toe drain
Cut-off trench
Kannah Creek
To be stripped as directed.
El 100.0
Gl. Valve-El 98.0
Apron El 96.0
Wye assembly
Dam Axis
Note: Location of cut-off walls is approximate only. Final location to be made in field.
85'-0"
20'-0"
116'-0"
262'-0" 30" I.D.-5/16" welded steel pipe encased in 6" concrete shell.
SECTION ALONG ℄ OF OUTLET CONDUIT
"CITY OF GRAND JUNCTION"
"1947"
FULL SIZE DETAILS OF RECESSES FOR LETTERS TO BE CAST IN CONCRETE
Reservoir level gauge
Grade to drain
Oil pump and engine foundation.
Sta. 3+00
PLAN
Letters to be cast in concrete. See details.
Two 3'x2' light commercial projected steel sash with mullion-Fenestra #32160 or equal.
Grade to flat slope.
CITY OF GRAND JUNCTION
1947
El 930
Inverted Filter
12" of 3/4" to 2" rock.
6" of 1/4" to 3/4" rock.
6" of conc. sand.
FRONT ELEVATION
NOTE: Set steel pipe to line and grade before pouring concrete encasement.
Lap 15"
Slope to suit material encountered in field.
Reservoir level gauge piping.
Locate four oil lines to hydraulic gates 4" each side of quarter points and tack weld to conduit at couplings.
Pour cut-off collars against natural ground.
Construction joint.
Boulders left in place to be cut back 6" min. from concrete and backfilled with selected material, tamped and shaped to grade.
Bottom of trench to be accurately shaped to fit bottom of conduit.
(TYPICAL SECTION)
SECTION B-B
SECTION D-D
Asphalt expansion joint filler.
30" I.D. pipe
SECTION ALONG ℄
El. 930
El. 900
Slope 0.01
El. 910
4 pieces 2 1/2" extra heavy pipe 12" long. Thread inside for 2" bar plugs. Weld to 30" I.D. steel pipe.
Oil pump and engine foundation.
2"-4 EH oil line housing
2"-4 EH oil line
Conduit barrel
30" I.D. x 5/16" steel pipe.
SECTION E-E
SECTION F-F
Oil lines
PIPE WELL DETAILS
1/2"ϕ hooked dowels into wall @ 16" c.c.
Groove horizontal joints. Rub vertical joints flush
NOTE: 3'-0"x 7'-0" industrial steel door with mortise cylinder lock. Richmond #23 or equal. (Set jamb in forms before pouring concrete.
8" Eave all around
7 Courses 8" Cinder block
Scupper
Floor El 96.0
El. 93.0
El. 86.0
1/2"ϕ @ 12" bathways
SIDE ELEVATION
VALVE CONTROL HOUSE
Oil lines
Pour conc against natural ground.
All transverse and hoop bars 3/4" @ 6"
All longitudinal bars 5/8"ϕ (16 required)
SECTION C-C
SECTION G-G
Inverted Filter
Approved on the 24 day of May 1947
By H. C. Hinderlider STATE ENGINEER
By DEPUTY
CITY OF GRAND JUNCTION
R. J. TIPTON AND ASSOCIATES INC., ENGINEERS
DENVER, COLORADO
IMPROVEMENTS TO WATER SUPPLY SYSTEM
HOGCHUTE RESERVOIR
OUTLET WORKS
VALVE CONTROL HOUSE
DRAWN N.L.L. APPROVED
TRACED F.B.C. APPROVED
CHECKED O.K. APPROVED
DENVER, COLORADO MAY 1947
705-32
C-454


PLAN
FRONT ELEVATION
SECTION A-A
SECTION B-B
TRASHRACK STRUCTURE
SECTION C-C
20" DRILLING TEMPLATE
OUTLET WYE
TYPICAL FIELD WELD
20" FLANGE DETAILS
PIPING DETAILS FOR TRASHRACK STRUCTURE
DETAIL OF TRASHRACK SEAT
CONTROL & GAGE PIPING
AIR VENT STACK
VALVE CONTROL PIPING DIAGRAM
SECTION ON ℄
PLAN
TRANSVERSE SECTION D-D
SPILLWAY DETAILS
NOTES
Steel outlet pipe, hydraulic gate valves, oil piping, pressure gauge piping, air vent piping and trashrack metal work to be furnished by the City.
CITY OF GRAND JUNCTION
R.J. TIPTON AND ASSOCIATES INC., ENGINEERS
DENVER, COLORADO
IMPROVEMENTS TO WATER SUPPLY SYSTEM
HOGCHUTE RESERVOIR
TRASHRACK STRUCTURE
AND SPILLWAY DETAILS
DENVER, COLORADO MAY 1947
705-33
C-454

Appendix D
Pertinent Geotechnical References

<*Insert images of pertinent geotechnical information*>

Appendix E
Pertinent Instrumentation Locations & Readings

<*Insert images of pertinent instrumentation monitoring records*>

Appendix F
PFM Likelihood, Confidence and Consequence Definition Tables

1. Likelihood Definition Table

PFM Failure Likelihood Rating	*Failure Likelihood Description*[9]	*Possible Actions to Reduce Probability of Failure*	*Possible Actions to Reduce Consequences*
VERY HIGH An active failure mode is in process or likelihood of a failure is judged to be extremely high, such that immediate actions are necessary to reduce risk. *Should be accompanied by a High Confidence.	There is direct evidence or substantial indirect evidence to suggest it is occurring and/or is likely to occur (or a flood or an earthquake with an annual exceedance probability more frequent (greater) than 10E-2 would likely cause failure.	<u>High Confidence</u> • Immediate draining of reservoir under SEO Authority • Emergency actions to avoid failure • Expedite investigations and designs • Zero Storage with Expedited Compliance Plan to Complete Investigations, Designs, and Construct Repairs, • OR issue Breach Order	• Ensure that emergency action plan is current and functionally tested for initiating event. • Initiate intensive emergency management and situation reports based on continuous monitoring. • Develop early warning system specific to PFM.
HIGH Potential failure mode is judged to present very serious risks, due to high probability of failure, which justifies an urgency in actions to reduce risk.	The fundamental condition of defect is known to exist; indirect evidence suggests it is plausible; and key evidence is weighted more heavily toward likely than unlikely (or a flood or an earthquake with an AEP between 10E-4 and 10E-2) would likely cause failure.	<u>Moderate to High Confidence</u> • SEO Storage Restriction to mitigate PFM. • Strict Deadlines for Compliance Plan to Complete Investigations, Designs, and Construct Repairs. • Conduct Heightened Monitoring specific to PFM. <u>Low Confidence</u> • Strict Deadline Expedited, high priority Compliance Plan to complete investigations & Studies to increase Confidence in PFM and justify further actions. • Conduct Heightened Monitoring specific to PFM.	• Ensure that emergency action plan is current. • Complete EAP functional exercise for initiating event.

[9] Use this column to differentiate AEP's between High, Significant, and Low Hazard Dams in the future.

PFM Failure Likelihood Rating	*Failure Likelihood Description*[9]	*Possible Actions to Reduce Probability of Failure*	*Possible Actions to Reduce Consequences*
MODERATE Potential failure mode appears to be dam safety deficiency that poses a significant risk of failure, and actions are needed to better define risks or to reduce risks.	The fundamental condition of defect is known to exist; indirect evidence suggests it is plausible; and key evidence is weighted more heavily towards unlikely than likely (or a flood or an earthquake with an AEP between 10E-5 and 10E-4 would likely cause failure.	<u>High Confidence</u> • Engineering judgment to consider possible storage restriction OR conditional full storage. • Conduct Heightened Monitoring specific to PFM. <u>Low to Moderate Confidence</u> • Strict Dates for Compliance Plan to complete investigations and analyses to increase confidence in PFM and support justification for remediation and remediation design, as appropriate. • Conduct Heightened Monitoring specific to PFM.	• Ensure that emergency action plan is current and functionally tested for initiating event.
LOW Potential failure mode(s) appear to indicate a potential concern, but do not indicate a pressing need for action.	The possibility cannot be ruled out, but there is no compelling evidence to suggest it has occurred or that a condition or flaw exists that could lead to its development (or a flood or an earthquake with an AEP more remote than 10E-5 would likely cause failure).	<u>Moderate to High Confidence</u> • Use Engineering Judgment to consider Conditional Full Storage OR Full Storage • Long term monitoring & instrumentation towards PFM to assess for worsening conditions. <u>Low Confidence</u> • Plan to complete investigations to increase confidence in PFMs. • Determine whether action can wait until after the next comprehensive review of the dam and appurtenant structures.	
REMOTE Potential Failure mode(s) at the facility do not appear to present significant risks, and there are no apparent dam safety deficiencies.	Several events must occur concurrently or in series to create failure. Most, if not all, events are unlikely to very unlikely, and failure potential is negligible or non-credible. The failure probability is unlikely to change with additional investigations or study.	<u>Moderate to High Confidence</u> • Full Storage • Continue routine dam safety risk management activities, normal operation, and maintenance. • Keep PFMs on list to indicate have been evaluated.	

2. Confidence Definition Table

Confidence Level	*Description*
Strong	The team is confident in the order of magnitude for the assigned category and, it is unlikely that additional information would change the estimate.
Medium	The team is relatively confident in the order of magnitude of the assigned category, but key additional information might possibly change the estimate
Poor	The team is not confident in the order of magnitude for the assigned category, and it is entirely possible that additional information would change the estimate.

3. Consequence Definition Table

Consequences Categories

Level 0:	No significant impacts to the downstream population other than temporary minor flooding of roads or land adjacent to the river.
Level 1:	Downstream discharge results in limited property and/or environmental damage. Although life-threatening releases occur, direct loss of life is unlike due to severity of location of the flooding, or effective detection and evacuation.
Level 2:	Downstream discharge results in moderate property and/or environmental damage. Some direct loss of life is likely, related primarily to difficulties in warning and evacuating recreationists/ travelers and small population centers (in the range of 1 to 10).
Level 3:	Downstream discharge results in significant property and/or environmental damage. Large direct loss of life is likely, related primarily to difficulties in warning and evacuating recreationists/ travelers and smaller population centers, or difficulties evacuating large population centers with significant warning time (in the range of 10 to 100).
Level 4:	Downstream discharge results in extensive property and/or environmental damage. Extensive direct loss of life can be expected due to limited warning for large population centers and/or limited evacuation routes.