

APPENDIX B

Summaries of Selected Studies and Data Reports

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Reports and studies with a direct bearing on watershed issues in the project area and in recent years were briefly described in this section. Reports containing data of water resource quality in the project area were summarized and reviewed critically from a planner's perspective with regard to the quality of the data toward watershed management.

Title:		
Evaluation of the U.S. Geological Survey Ground Water Data Collection Program in Hawaii, 1992		
Prepared By:	Prepared For:	Date
Anthony, Stephen S.	USGS	1997
Description:		
<p>This report describes an evaluation of the 1992 USGS ground water data collection program in Hawai'i. The program objectives include collecting sufficient spatial and temporal data to define seasonal and long-term changes in ground water levels and chloride concentrations induced by natural and man-made stresses for different climatic and hydrogeologic settings. The ground water data collection program requires two types of well networks in order to meet the objectives of the program: a water management network to determine the response of ground water flow systems to human-induced stresses and a baseline network to determine the response of ground water flow systems to natural stresses.</p> <p>The wells in the 1992 data collection program for the islands of O'ahu, Kaua'i, Maui, Molokai, and Hawai'i are described with maps showing the distribution and magnitude of pumpage, and the distribution of proposed pumped wells. Wells that provide data for mapping water levels and chloride concentrations are identified followed by locations where additional wells are needed for water level and chloride concentration data. In addition, a procedure to store and review data is described.</p> <p>Data were collected from several types of wells: (1) observation wells, (2) deep monitoring wells, (3) free-flowing wells, and (4) pumped wells. The Moanalua ground water area has three pumped wells with a combined pumpage of about 10.4 mgd in 1990. Three additional pumped wells are proposed. There are fourteen pumped wells in the Honolulu ground -water area that had a combined pumpage of 36.9 mgd in 1990. Nine additional pumped wells are proposed. Both the Moanalua and the Honolulu areas were identified as needing water-management networks.</p>		

Title:		
Land Use and Coastal Water Quality: Planning Purposes, Critical Areas Management		
Prepared By:	Prepared For:	Date
Bartram, Paul D.	Hawaii Environmental Simulation Lab	May 1975
Description:		
<p>This paper discusses different strategies in approaching land use problems at different scales including geographic and problem magnification levels. Water quality goals and management are discussed in terms of State water quality standards. On a statewide scale, degradations to water quality including biostimulation, siltation, toxicity, pathogens, and thermal effluent are identified based on general land use activities (natural, agriculture, residential/urban, and commercial/industrial) and points of intervention are suggested where applicable.</p> <p>The islandwide scale investigates critical areas and issues and the range of management alternatives. Pollution impacts on coral reefs are discussed. Table 9 consists of "Categories of Man-Made Water Quality Modifications and their Effects on Recreational and Marine Environments." Additional tables include a Statewide Ranking of Water Segments; An Analysis of Present Plans, Water Quality Segments; State Ranking of Discharges; and Rock Types and Characteristics for Receiving Waters.</p>		

Title:		
Proposed Disposal of Solid Waste Bales in Keehi Lagoon and the Coastal Waters of Oahu - Revised Environmental Impact Statement		
Prepared By:	Prepared For:	Date
Bogost, Meyer S. and the Ralph M. Parsons Company	CCH Department of Public Works	Dec 1999
Description:		
<p>This was a proposed project to dispose of baled solid waste into the Ke'ehi Lagoon and other coastal waters of O'ahu. Approximately 1,000 tons of baled waste was to be placed in barricaded near-shore areas where it would eventually be covered and used as recreation areas or for other purposes. The proposed site in Ke'ehi Lagoon was the near-shore area around the Honolulu International Airport and Hickam Air Force Base. The primary objective was to provide a disposal area within metropolitan Honolulu in order to save costs as well as to create approximately 72 acres of reclaimed land.</p> <p>The document includes historical, water quality, geologic, flora, fauna, and land use data for the Ke'ehi Lagoon area. The document also contains a figure on general ocean current circulation patterns around O'ahu as well as a limited discussion of alternative solid waste disposal possibilities.</p>		

Title:		
Occurrence of Organochloride Pesticides in Stream Bed Sediment and Fish from Selected Streams on the Island of Oahu, Hawaii, 1998		
Prepared By:	Prepared For:	Date
Brasher, Ann and Stephen S. Anthony	USGS	1998
Description:		
<p>The purpose of this study was to determine which organochloride contaminants are present in streams on O'ahu, and with which land uses they are associated. Streambed sediment and fish samples were collected from six streams that flow through four representative land use types: agricultural, urban, conservation, and mixed agricultural and urban use. Collection and processing methods were consistent with national procedures, with all samples being analyzed at the USGS National Water Quality Lab in Arvada, CO.</p> <p>The concentrations of dieldrin and chlordane from samples taken from Nu'uaniu Stream exceeded the Canadian Sediment Quality Guidelines Probable Effect Level (CSQG PEL) for sediment samples and the New York State Department of Environmental Conservation (NYSDEQ) guidelines for fish tissues samples. Some DDE was detected in Nu'uaniu Stream sediments, but concentrations did not exceed the recommended CSQG PEL. Similarly, some DDT was detected in Nu'uaniu Stream fish tissue, but concentrations did not exceed NYSDEQ guidelines.</p> <p>The reports concluded that organochloride pesticides are transported from agricultural and urban sources primarily through soil erosion/runoff, and persist in O'ahu's aquatic ecosystems although they are no longer in use.</p>		

Title:		
Necropsy and Liver Histopathology for Fish Sampled in the Vicinity of the Sand Island Ocean Outfall and in Maunalua Bay, Oahu, Hawaii		
Prepared By:	Prepared For:	Date
Brock, James A.	ENV	Dec 1999
Description:		
<p>Fish liver histopathology is an important biological tool used to assess fish for exposure to pollution. The results of this study show that 10 out of 60 fish tested had signs of enlarged bile ducts probably due to Myxosporidea spores and metazoan parasites found in their biliary systems.</p>		

Title:		
Storm Drain and Street Cleaning Effectiveness Report: City and County of Honolulu Municipal Separate Storm Sewer System NPDES Permit No. HI0021229		
Prepared By:	Prepared For:	Date
ENV	ENV	Apr 1999
Description:		
<p>This study was conducted by the City and County of Honolulu to evaluate the effectiveness of their street sweeping program as required for their municipal NPDES permit. The objectives of the study were to determine if street sweepers are removing the build-up of pollutants from City streets, thereby controlling migration into receiving waters and the atmosphere. The study area covered in this report includes selected streets in the Salt Lake area, as examples of typical residential conditions which can then be used as a baseline for other areas on the island. The Salt Lake Drainage basin discharges into Moanalua Stream.</p> <p>Material collected during the street sweeping operations was analyzed, as were residue samples from two catch basins in the drainage area. Rainfall events were incorporated into the analysis. The study compared the effectiveness of mechanical versus regenerative street cleaners, as well as cleaning frequency.</p> <p>The lab analysis revealed significant amounts of <i>oil and grease</i> (3,141 mg/Kg), <i>lead</i> (35 mg/Kg), <i>zinc</i> (177 mg/Kg), and <i>copper</i> (102 mg/Kg) in the street sweeping residue, as listed in table 2, page 14. The collected material was also classified by particle size. The results found that street sweeping is effective in controlling litter, debris, and gravel build-up, but only moderately effective in controlling oil, grease, and heavy metals. As a water pollution control, street sweeping is only modestly effective as compared to other stormwater pollution preventative measures.</p> <p>The Report recommended that street sweeping needs to be combined into an integrated storm water management program, including source control, public outreach, and enforcement. The street sweeping program should have clear objectives. The sweeping appears to be beneficial when analyzed for large particle pick-up but only moderately effective when analyzed for collection of fine materials and the contaminants that typically bind to them. Also, a discussion of the catch basin samples with and without the sweeping program would be helpful in determining if the amount of contaminants that are moving into the storm system are affected by street sweeping activities.</p>		

Title:		
Fiscal Year 2001 End-of-Year Report for the City and County of Honolulu Municipal Separate Storm Sewer System NPDES Permit #HI0021229		
Prepared By:	Prepared For:	Date
ENV	ENV	Oct 2001
Description:		
<p>The purpose of this report is to fulfill the requirements of the NPDES Permit, which includes an “evaluation of all storm water control measures implemented during the past fiscal year.” This document discusses (1) highlights of significant successes; (2) areas of concern; (3) proposed changes, modifications, and revisions to program activities; (4) status and effectiveness of control measures; (5) inspection and enforcement actions; (6) evaluation of FY01 public education program activities; (7) public education program for FY02; (8) summary and analysis of monitoring data; (9) identification of water quality improvements or degradation; and (10) FY01 expenditures and proposed FY02 budget. Significant successes include recognition of the NPDES Public Education program that is a part of the Storm Water Management Program; the addition of a biological assessment to the Storm Water Management Program; an assessment of Lower Hālawā Stream by the University of Hawai‘i Stream Research Center; the publication of three standard research documents: (a) Rules Relating to Soil Erosion Standards and Guidelines, (b) Best Management Practices Manual for Construction Sites in Honolulu, and (c) Rules Relating to Storm Drainage Standards, and a continuation of City partnerships with other agencies and organizations. Areas of concern include the implementation of EPA policies for TMDLs on the City’s storm water management program, the lack of Phase II NPDES guidelines on municipal facilities, and the need for inspection and maintenance of storm drains. The Road Maintenance Division received an increase in the number of complaints from 79 in FY00 to 161 in FY 01. The cause of the increase is undetermined. A biological assessment of Moanalua Stream will be conducted in FY02. There has been no measurable change in water quality.</p>		

Title:		
Keehi Lagoon Recreation Plan Final Environmental Impact Statement		
Prepared By:	Prepared For:	Date
Edward K. Noda and Assoc., Inc.	DOT	1989
Description:		
<p>Objectives include support of economic growth (expansion needs of Honolulu International Airport and Honolulu Harbor), recreation (regattas and water skiing), ocean research, and education activities, and achieving these objectives through private sector funding, where possible. Objectives for the specific studies involving water quality, benthic communities, and avifaunal populations were to identify species and habitats, and to describe their characteristics.</p> <p>Methodology for the water quality study included collection of samples during one day, from eight stations in the lagoon at various depths. Dissolved oxygen samples were taken first, then the remaining samples were drawn. Temperature of each sample was taken, then chemical analyses were conducted at the on-shore lab, including salinity on a precision induction salinometer, pH based on the Strickland-Parsons method, turbidity in a Turner Designs Model 40 Nephelometer calibrated against a 20 NTU latex suspension standard, and suspended solids were filtered onto a tared Whatman GF/C glass fiber filter, dried to 60°C, and weighed on a Mettler analytical balance. Dissolved nitrate, ammonium, and orthophosphate analyses were performed on water samples filtered through a Whatman GF/C glass fiber filter and a Technicon AutoAnalyser II system interfaced with an Apple IIe and an MCI analog-digital converter. For the benthic and avifaunal communities surveys, field reconnaissance and general notes were taken on the environmental conditions and species present at various points in the study area.</p> <p>Findings/Recommendations Projects identified (Construct “Triangle development” [research, recreation, commercial, light industrial], develop marina along Lagoon Drive, construct a canoe center, and to construct a swimming beach off the southern tip of Sand Island) would have minimal impacts on the existing environment, including for the infill required for the “Triangle development.” No impacts were foreseen on the outer reef due to this project. Water circulation would be positively impacted due to the implementation of the project, thus the preferred alternative would have the least environmental impact. No adverse impacts on water quality were predicted.</p> <p>Comments No sediment testing for the presence of heavy metals in near-shore waters. Need to understand habitat extent of ‘o‘opu and other anadromous species observed in Moanalua and Kalihi Streams. Need more emphasis on water quality in areas intended for fishing, swimming, and boating. Potential industrial impacts on shoreline/estuary should be carefully reviewed. The land-sea relationship was not recognized, nor was the need to acknowledge the relationship between near-shore waters and native aquatic species present in the upper watershed, such as ‘o‘opu and ‘opae. Although sedimentation of the Lagoon is mentioned, contamination of sediments was not discussed. No specific mention of heavy metal contamination in the investigation. The report would have benefited from a comparison to current Water Quality Standards, an analysis of heavy metals in Lagoon sediments, and an inventory of native aquatic species.</p>		

Title:		
Prefinal Sediment Sampling and Analysis Report: Moanalua and Kalihi Streams, DLNR Project No. E00BO51A and E00BO51B		
Prepared By:	Prepared For:	Date
Environet, Inc.	DLNR	Aug 2001
Description:		
<p>The DLNR intends to conduct maintenance dredging in Kalihi and Moanalua Streams on lands within their jurisdiction near the discharge waters of Ke'ehi Lagoon. The purpose of this study is to collect and analyze sediment samples from the two streams to identify potential chemicals of concern (COC) in the sediment that may affect dredge spoil management and disposal requirements. This report contains primary data on the sediments collected and includes the identification and evaluation of potential disposal options for dredged material based on sediment analysis results.</p> <p>The methodology for sample collection and analysis are described and includes EPA-recommended chain of custody protocol and documentation. Testing for specific types of contaminants was determined based on local landfill waste profiling and Resource Conservation and Recovery Act hazardous waste identifiers. Each analysis followed methods approved by the appropriate Federal agency or organization.</p> <p>The samples were collected May 21-23, 2001. Chemicals of concern identified during the study included: <i>heavy metals, petroleum hydrocarbons, ethylene glycol, volatile organic compounds (VOC), semi-volatile organic compounds (SVOC) including PCBs, organochlorine pesticides, and chlorinated pesticides.</i> A complete listing of the analytical results is provided in Tables 3-9 through 3-16 in the report.</p> <p>Three sediment disposal options are detailed in Section 4 of the plan: confined disposal into a permitted landfill after upland confined disposal for dewatering, open water ocean disposal, and beneficial use as fill on State lands. The three options are compared based on the required regulatory approvals, the additional steps required prior to disposal, and the estimated construction costs (if disposal is acceptable). No recommendations are made as to the preferred disposal method.</p> <p>It was not clear if other portions of Kalihi and Moanalua Streams are in need of dredging, or if the report concentrated on only those areas under the jurisdiction of the Department of Land and Natural Resources. The extent of the dredging should be defined irrespective of agency jurisdiction. Also, other beneficial uses such as agriculture, construction, and industrial were mentioned but not investigated as possible disposal options. There is no mention of copper, a toxic metal associated with brake pads.</p>		

Title:		
Dam Safety Inspection, Nu‘uanu Reservoir No. 4, Oahu, Hawaii [W.O. 92-2285]		
Prepared By:	Prepared For:	Date
Ernest K. Hirata and Assoc., Inc.	DLNR- Department of Water and Land Development	Nov 1993
Description:		
<p>The purpose of this study was to evaluate the integrity of the dam at Nu‘uanu Reservoir No. 4 in order to protect human life and property. The inspection was done to ensure proper operation and maintenance, to identify potentially unsafe conditions, and to determine the causes or mechanisms of any problems or deficiencies. This report includes: (1) location information; (2) ownership and contact information; (3) a dam description; (4) an assessment of the downstream hazards; (5) an overview of the operation, maintenance and inspection program; (6) the history of the dam; (7) field observations and assessment; (8) an evaluation of the emergency action plan; (9) regional and site geology; (10) a hydraulic and hydrological assessment of the Stream and dam; and (11) recommendations for the dam. Recommendations regarding the Civil Defense Emergency Action Plan include: (1) prepare a formal plan for the daily operation of the dam, (2) prepare formal plans for operation of the gates during high floods and rapid rise of reservoir elevation for various scenarios, and (3) prepare formal operational guidelines in conjunction with the Civil Defense Evacuation Plan. Other recommendations include: (1) maintain access to all existing monitoring equipment and monuments and to all identified seepage areas, (2) replace and maintain the access bridge, (3) assess the condition of the lower gate, (4) assess the old Contractor's Tunnel and outlet pipe, (5) clear all vegetation in the discharge area downstream of outlet pipe, (6) clear vegetation from the entrance/approach channel, (7) clear all vegetation in the discharge channel downstream of the dam, (8) produce a comprehensive topographic map of the dam and its vicinity with locations of seepage areas, (9) create a map of all monitoring instruments, (10) create monuments to survey the crest elevation and a point of reference to determine the location of existing monuments, (11) determine the axis of the dam with proper stationing, (12) create cross sections for piezometer data, (13) install toe drains at Seepage Area Nos. 1 and 2, and (14) measure seepage.</p>		

Title:		
Phase II Dam Safety Investigation Nuuanu Reservoir No. 4, Honolulu, Hawaii [W.O. 99-3133]		
Prepared By:	Prepared For:	Date
Ernest K. Hirata and Assoc., Inc.	BWS	May 1999
Description:		
<p>Objectives of this investigation included 1), an evaluation of dam safety in compliance with the DLNR's <i>Guidelines for Safety Inspection of Dams</i>, "Chapter IV – Phase II Investigation," December 1992; 2), identification of potential hazard to public health, safety and welfare; 3), assessment of dam properties through studies, investigations, and analyses including visual inspections, measurements, foundation exploration and testing, material testing, structural stability analysis, hydraulic and hydrologic analyses to include flows through the dam, the foundation, and contribution of rainfall to the gage; 4) identification of areas that require immediate remedial action, complete with alternatives, cost estimates, and a preferred action.</p> <p>Methodology included a review of the operation and maintenance of the dam, visual inspection of the structure, soil, slope, and hydrologic analyses. A contractor removed heavy vegetation along the downstream discharge channel and selected boring areas. A licensed surveyor provided a topographic map of the dam and its vicinity to delineate the approximate location of seepage areas and seepage points with proper stationing and elevations. Seven exploratory borings were conducted to assess flow pressure, soil type, and water level data. A geotechnical consultant performed a stability analysis.</p> <p>Findings/Recommendations The safety of Nu‘uanu Reservoir No. 4 was evaluated in compliance with the DLNR's <i>Guidelines for Safety Inspection of Dams</i>, "Chapter IV – Phase II Investigation," and found to meet the requirements for hydraulic and stability analyses. With the exception of some potential flooding downstream of the dam which might occur under extraordinary conditions (requiring with an initial pool at the spillway crest elevation prior to the adopted Probable Maximum Flood (PMF) and/or flooding in excess of the adopted PMF), there do not appear to be any immediate hazards to the public, health, safety, and welfare. Should a consistently followed monitoring program show any degradation of the embankment dam as evidenced by increased seepage flow quantities, increased turbidity in seepage flows, or embankment deformation/cracks, the hazard should be immediately re-assessed.</p> <p>There are areas requiring remedial actions that are addressed in the recommendations:</p> <ul style="list-style-type: none"> • keep spillway, embankment, and seepage areas free of vegetation to facilitate observation; • develop collection pools and install flow measuring weirs at selected seepage areas; • maintain monitoring equipment; and • maintain pool elevation at or below 995 feet. <p>Comments Would an increase in flow turbidity volume precede a potential failure of the dam, or could the structure fail without warning? There is no certainty that the seepage is due to the highly permeable cinder soil beneath the dam or from a fracture in the structure itself. The stability analysis resulted in a 1.19 factor of safety in the sudden drawdown scenario, whereas the minimum required is 1.2. Partial pool with seismic loading was 1.22. The conservative assumed values used in the formulae resulted in "adequate" determinations of safety in the various scenarios. Are the criteria in Phase II Dam Safety Investigation an accurate representation of the condition of the dam and of safety factors at Nu‘uanu Reservoir No. 4?</p>		

Title:		
Evaluation of the Surface-Water Quantity, Surface-Water Quality, and Rainfall Data Collection Programs in Hawaii, 1994		
Prepared By:	Prepared For:	Date
Fontaine, Richard A.	USGS	1994
Description:		
<p>This report evaluates surface-water quantity, quality, and rainfall data collection programs on the five major islands of Hawai'i, Hawai'i, Kaua'i, O'ahu, Maui, and Molokai, through 1994. The evaluation included four steps: (1) identify current issues and long-term goals for the data collection programs, (2) describe the current status of the data collection programs and develop a GIS database summarizing the historical and current surface water quantity gages operated, (3) evaluate the data collection programs to determine which goals were achieved and which programs are adequate to address goals that have not been achieved, and (4) describe alternative data collection and interpretive techniques that can be used to identify deficiencies in the current data collection programs.</p> <p>The current surface-water quantity database only adequately addresses 2 of the 14 specific issues and related goals of the program. Alternatives identified to address those deficiencies include new and expanded data collection, use of regional regression analyses, hydrologic and hydraulic modeling, and analysis and publication of existing data. Stream-gaging stations are needed on an additional 47 streams.</p> <p>Limitations of the surface-water quality program included lack of data regarding suspended sediment, land-use effects, quality of stream discharge into oceans, background water quality, nonpoint sources of contamination, and the need for improved coordination between the numerous agencies involved with surface-water quality issues.</p> <p>Data for the rainfall data program only partially met the identified goals. Concerns regarding the limitations include the need for additional recording gages and the effect of plantation closings on the gages they operate.</p> <p>Evaluation of the data collection programs should be continuous and available through databases and published reports.</p>		

Title:		
Statewide Capital Improvement Program, Flood Control Projects, Report R98		
Prepared By:	Prepared For:	Date
Fukunaga & Assoc., Inc.	DLNR-Department of Water and Land Development	Apr 1994
Description:		
<p>This report may be considered an extension of the State General Flood Control Plan updated by the DLNR in 1983. The purpose of this study was to formulate criteria for a State Capital Improvements Program (CIP) for flood control improvements and engineering studies and to identify State funding opportunities to supplement County and/or Federal flood control projects. This report includes the identification of flood-prone areas in the state, an assessment of their hazard potential, flood damage mitigation measures, an inventory of flood control projects, development of general criteria for the selection of flood control projects appropriate for placement on the CIP, development of specific technical criteria for establishing priorities for placement of projects on the CIP, and identification of areas requiring further investigation. Evaluation criteria in determining prioritization include loss of life, historical and potential damages, land use, extent of flooding, existence and effectiveness of remedial measures, environmental and social concerns, ownership of stream right-of-way, and ownership of lands being flooded. Eighty-six on-going projects were listed for five islands, with 10 of them being high priority, 15 median priority, 61 low priority, and 2 undetermined. The Kalihi Stream Improvement Study is a median priority project that recommends investigation into less costly alternatives to prevent flooding. The previously proposed project included 8,400 feet of channel improvements upstream from the stream mouth, a system of levees, concrete-lined rectangular and trapezoidal channel sections, and trapezoidal sections with rip-rapped side slopes, but was considered too costly to implement (benefit-to-cost ratio of 0.5). The Moanalua area was considered low priority. Existing conditions and reasons for flood conditions are discussed, as well as past flood events. A flood control project was proposed by the City and County of Honolulu in 1979 but was never implemented.</p>		

Title:		
Plan to Enhance Water Quality in Keehi Lagoon and Ponds Makai of Proposed Reef Runway (8R26L)		
Prepared By:	Prepared For:	Date
Harvey, G., R. Palmer, J. Walker, and T. D. Kartha	Ralph M. Parsons Company	Feb 1971
Description:		
<p>The purpose of this plan is to identify the concept that would provide the most satisfactory circulation pattern and greatest improvement in ecological conditions in Ke'ehi Lagoon in a cost-effective manner. Previous investigations and model studies were reviewed, factors affecting circulation were identified, and a plan was developed using those circulation factors to minimize the effects of pollution.</p> <p>The report concluded that (1) the circulation plan for the reef runway construction is designed to take advantage of the prevailing trade winds; (2) after runway construction, wind driven currents would be directed toward a deep channel at the east end of the runway by a causeway and floatables could be guided to a collection point by a low vertical wall along the channel; (3) deepening the northeast-to-southwest and east-to-west seaplane runways would result in less wind setup in the Lagoon; (4) the polluted water from the northern and eastern portions of Ke'ehi Lagoon would be blocked by the proposed reef runway, thereby facilitating healthy growth of a long stretch of coral reef south of the runway; and (5) early suggestions to use some of the area between the runway and the present shoreline for aquaculture are feasible.</p> <p>The report has several recommendations: (1) construct the proposed entrance channel approximately 200-300 feet wide at the east end of the reef runway at a depth of about 50 feet and directed from the Lagoon toward the southwest; (2) additional calculations should be carried out to determine flow characteristics of the channel and to optimize the dimensions; (3) deepen the seaplane runway channel between the Ahua Point fill and the new entrance channel at the east end of the reef runway to 50 feet to increase the flow of deeper water into the entrance channel.</p>		

Title:		
Hawaii Stream Assessment: A Preliminary Appraisal of Hawaii's Stream Resources, Report R84		
Prepared By:	Prepared For:	Date
Hawaii Cooperative Park Service Unit	DLNR-CWRM	Dec 1990
Description:		
<p>This report identifies rivers, streams, or portions thereof with significant scenic value to be recommended for placement in the wild and scenic rivers system for protection and preservation. Streams were inventoried and assessed based on aquatic, riparian, cultural, and recreational values. Included are an inventory of perennial streams and their physical characteristics, potential stream users, and an assessment of four types of stream resources: aquatic, riparian, cultural, and recreational. The report also discusses monitoring and modifications. The study concluded that the state's surface water resources are limited, fragile and in need of immediate protective management. Potential future actions included: (1) maintaining and enhancing the Hawaii Stream Assessment by initiating studies, workshops, and the development of master plans; dedicating a CWRM staff position specifically and exclusively to conservation; and requesting the Office of Planning to make streams a theme of the state GIS database; (2) developing long-term stream management strategies by adopting a Hawai'i Stream Policy that protects important natural, cultural, and recreational values; establishing a Hawai'i Stream Plan with General Guidelines and a Protected Streams Program; and (3) implementing interim actions to preserve management options, such as declaring a moratorium on the development of significant streams and using Hawaii Stream Assessment General Guidelines in the interim. The Water Commission suggested the development of alternatives to the wild and scenic river system but no actions, protections, designations, or zoning changes were initiated.</p>		

Title:		
Geohydrology of the Island of O‘ahu, Hawaii: Regional Aquifer System Analysis, USGS Professional Paper 1412-B		
Prepared By:	Prepared For:	Date
Hunt, Charles, D., Jr.	USGS	1996
Description:		
<p>This paper is a narrative explanation of groundwater resources for the Island of O‘ahu. It covers such topics as the geological framework, e.g., hydraulic properties of volcanic structures, modes of ground water including the basal aquifer, dike-impounded groundwater, and perched water; the regional aquifer system; and ground water flow systems. The summary contains an estimate of pre-development groundwater recharge volumes for Hawai‘i by flow region, totaling 792 million gallons per day.</p> <p>Contains 54 pages including illustrations, tables, and an extensive list of references.</p>		

Title:		
Bacterial Indicators in Kapalama Canal, O‘ahu: Technical Memorandum Report No. 37		
Prepared By:	Prepared For:	Date
Johnson, J. M., M. D. Ells and R. H. F. Young	Pollution in Hawaiian Watersheds	Jan 1974
Description:		
<p>A four-month study was conducted on the levels of bacterial indicators in the Kapālama Canal in the open portion from just mauka of School Street to Honolulu Harbor. The study was conducted between March and July 1971 and compared the levels of total coliforms, fecal coliforms, fecal streptococcus, and <i>Pseudomonas aeruginosa</i>, the latter a pathogen only of man. Results showed that the levels of coliform bacteria exceeded the State Water Quality Standards, giving strong indication of sewage contamination possibly from illegal household connections or cesspool leakage.</p> <p>This publication includes limited infrastructure, historic, and economic information on Kapālama Canal. This research was supported in part by the Allotment Project “Pollution in Hawaiian Watersheds” (A-027-HI). Portions of the results were originally published in the WRRC Technical Report No. 59, Water Quality of Kapālama Canal.</p>		

Title:		
Koolau Mountains Watershed Partnership Management Plan Final Draft		
Prepared By:	Prepared For:	Date
Koolau Mountains Watershed Partnership	Koolau Mountains Watershed Partnership	2002
Description:		
<p>The purpose of this study is to manage the inland forest regions of the watershed in order to efficiently recharge the underground aquifers, provide habitat for flora and fauna, and temper the erosive effects of rain. This report (1) characterizes the current biophysical and socio-cultural resources located within the watershed area, (2) highlights the threats to those resources, (3) summarizes management activities that are currently in place to address the threats, (4) prescribes priority management activities and accent planning needs where necessary, (5) considers environmental impacts, and (6) suggests protocols to monitor recommended activities. Recommended management activities include (1) threat management of invasive non-native plant species, feral ungulates, and other non-native animals, human activities, aquatic pollutants, and wildfire; (2) water resources and watershed management; (3) biodiversity protection; (4) cultural resources management; (5) education, awareness, and public outreach via media and public education, community outreach and education, volunteer opportunities, and community partnerships; and (6) administrative coordination and communication. Monitoring is also recommended to determine the relationship between forest health and water quality and quantity, management program indicators, and administrative coordination and communication indicators.</p>		

Title:		
Estimation of Urban Stormwater Quality in Kalihi Stream Drainage Basin, Oahu, Hawaii: Technical Memorandum Report No. 45		
Prepared By:	Prepared For:	Date
Nakamura, M. N. and Reginald H. F. Young	Pollution in Hawaiian Watersheds	Dec 1974
Description:		
<p>This study was an attempt to correlate pollution associated with street litter with baseline data from a previous Kalihi Stream study (<i>Baseline Quality for Kalihi Stream</i>, Young and Matsushita, 1971). Results showed that the overall comparability of obtained estimates with existing storm water quality data suggests the possibility of obtaining fairly acceptable quantification of pollution potential attributable to urban runoff by utilizing the prescribed procedures. The study also pointed out the apparent lack of water quality data for urban storm water in Hawai'i. While it is difficult to treat this problem of non-point source pollution, the authors recommend more studies to be done on this subject. The report also includes a limited description of study area (geography, climate, and land use).</p>		

Title:		
Interstate and Defense Highway Route H-3 Moanalua Stream Relocation, Planning Report Appendix B: Moanalua Stream Design		
Prepared By:	Prepared For:	Date
Parsons Brinckerhoff Hirota and Assoc.	DOT – Highways Division	1967
Description:		
<p>The purpose of this study was to establish adequate design criteria for protection of the proposed H-3 Freeway against stream floods. Moanalua Stream meanders across the entire valley, and therefore does not allow sufficient floor area to accommodate the highway without disturbing the stream. These criteria have been recommended for use: stream crossings or channel relocations should be designed for a 50-year flood discharge, estimates of the 50-year flood discharge should be calculated under future conditions with the stream relocated, and the 50-year flood discharge for future conditions should not exceed flood discharge for the same frequency for existing conditions at the downstream end of the project.</p> <p>Included in this report is a description of the watershed, a flood frequency analysis, an evaluation of the 50-year design flow under future conditions, a description of the variation of the design discharge with distance along the stream, a description of flood routing, hydraulic design, and a south branch dam.</p> <p>Two alternatives for stream relocation were studied: an open channel scheme and a culvert scheme. Both alternatives resulted in higher 50-year flood peak flow estimates under existing conditions, therefore making it necessary to implement measures to reduce peak flows. A detention dam on the south branch of Moanalua Stream would reduce the 50-year peak flow under future conditions to below existing peak flow conditions.</p>		

Title:		
Kapalama Canal Conceptual Plan Study		
Prepared By:	Prepared For:	Date
R. M. Towill Corporation	CCH Department of Public Works	Mar 1980
Description:		
<p>This study provides a conceptual plan for aesthetic and stream bank improvements for Kapālama Canal. The intent was to improve existing passive recreation along banks, create a park in the former incinerator site, and increase channel capacity. Recommendations include providing vertical CRM walls along 3,200 feet of the canal, platforms for fishing and launching of small hand-carried boats, a pedestrian promenade with shade trees and picnic facilities, a mini-park on the former incinerator site, an H-1 pedestrian overpass at Kōhou Street, improvement of Kōkea Street to City standards, and landscaping of sidewalk areas. Bikeways are not recommended as part of the conceptual plan due to projected use conflicts.</p> <p>The study provides a detailed description of existing conditions, including land use, geographical characteristics, and traffic circulation. The study document includes several cross-sections, perspective and plan view drawings complete with dimensions, and phasing and cost estimate information.</p>		

Title:

Negative Declaration of the Kapalama Canal Flood Control, Landscaping and Beautification Project, Honolulu, Hawaii

Prepared By:

R. M. Towill Corporation

Prepared For:

CCH Department of Public Works

Date

May 1980

Description:

This document is a negative declaration for the Kapalama Canal Conceptual Plan prepared in March of 1980. It provides a description of the affected physical and socio-economic environment, the identification and evaluation of potential environmental impacts and mitigative measures, alternatives to the proposed actions, construction phasing, and the basis for negative determination. Also included is a list of the agencies consulted during this process, and a section containing comments made during the consultation process. The negative determination means that there would be no adverse impacts to the physical or socio-economic environment.

The document is comprised of 17 pages, including project area maps and tables containing data on water quality. The water quality tables did not include a study objective, methodology, source, or year that the survey was conducted. Physical, chemical, and biological water quality of Kapalama Canal were presented as follows:

1978

TABLE 1
PHYSICAL AND CHEMICAL WATER QUALITY OF KAPALAMA CANAL

Year?
8/2/80

Parameter	Standard (Let Season)	Site No. 1 (No. of Samples)	Site No. 2 (No. of Samples)
Temperature (°C)	--	25.3(4)	25.3(4)
Dissolved Oxygen mg/l	80% Saturation = 6.7 mg/l @ 25.3°C	5.8(6)	5.7(6)
Turbidity (JTU)	5	15.1(5)	14.5(5)
Total Kjeldahl Nitrogen (mg N/l)	0.2	0.52(6)	0.45(6)
NO ₂ + NO ₃ - N (mg N/l)	0.07	0.12(6)	0.16(6)
Total P (mg P/l)	0.05	0.13(6)	0.11(6)
pH	5.5 to 8.0	7.9(4)	7.9(4)

TABLE 2
BACTERIOLOGICAL WATER QUALITY OF KAPALAMA CANAL
GRAB SAMPLES OF 9/24/79

Sample ID No.	Location	Total Coliform (MPN/100 ml)	Fecal Coliform (MPN/100 ml)
1	Makai at Dillingham Bridge, Center	2400	2400
2	Mauka of Dillingham Bridge, Center	3500	1300
3	Mauka of King Street Bridge, Center	2400	1600

Title:		
Engineering Study of Surface and Tunnel Water Sources, Contract No. c54960		
Prepared By:	Prepared For:	Date
Richard M. Sato and Assoc.	BWS	Jun 1992
Description:		
<p>The purpose of this study was to assess the existing conditions of the BWS's tunnels and appurtenant structures and to recommend actions necessary to protect these structures from surface contamination, including insects, plants, and animals. The structures studied were: Waianae Tunnels 6, 15, and 19 and breaker box; Kalihi Tunnels 3, 4, 5 and 6; Nu'uaniu Tunnels 3, 3A, 4, and 4B; Alewa Heights Spring; Booth Spring; Makiki Springs (A) and (B); Herring Springs (A) and (B); Mānoa Tunnel; Palolo Tunnel and breaker box; Waimanalo Tunnels; Hai'kū Tunnel; Luluku Tunnel; and Kahalu'u Tunnel. The report includes the location and a description of the structures, assessment of conditions, recommendations for improvements, and cost estimates. Pictures of each structure are also included as an appendix.</p>		

Title:		
Flood Hazard Study, Kalihi and Kamañaki Stream, Oahu, Hawaii		
Prepared By:	Prepared For:	Date
Sam O. Hirota, Inc.	COE	Sep 1977
Description:		
<p>The purpose of this study is to provide general flood hazard information along the upper reach of Kalihi Stream and its main tributary, Kamañaki Stream. Specifically, the report covers the area of Kalihi Stream between School Street and the Forest Reserve boundary at 520 feet above msl, and the area of Kamañaki Stream from its confluence with Kalihi Stream near Laumaile Street and Puolani Street. Included in the study are a basin description, flood history, a description of the flood problem, hydrology, and flood outlines.</p> <p>The most destructive flood of Kalihi Stream occurred on November 18, 1930, when a discharge of 12,400 cfs was recorded. Fourteen persons were killed in the flood, 100 families were evacuated, and property damages were estimated at \$240,000. There is no recorded history of flooding on Kamañaki Stream, however, a flood on April 19, 1974 caused the collapse of a retaining wall near Violet Street and channel banks were overtopped near Noe Street and Wailele Street. Peak discharges were recorded at 7,110 cfs on Kalihi Stream above its Kamañaki Stream intersection.</p> <p>The study concludes that flood problems on both streams are caused by limited capacities of existing stream channels to accommodate storm runoff during moderate to high peak discharges. Additionally, Kalihi Stream flooding may result from the blockage of bridge openings by debris, thereby creating a backwater effect that floods low-lying areas. Kamañaki Stream flooding may be increased by its narrow and irregular channel sections with sharp bends and abrupt changes in flow direction that limit channel capacity and cause flooding and spreading of floodwater. Accumulation of debris in Kamañaki Stream may also contribute to flood problems.</p>		

Title:		
Analysis of the Rainfall-Runoff Relationship in Moanalua Valley, Oahu, Hawaii		
Prepared By:	Prepared For:	Date
Shade, Patricia J.	UH Geography Department	1981
Description:		
<p>The purpose of this report is to define the rainfall-runoff relationship in the natural watershed portion of Moanalua Valley. Supporting objectives include: (1) determine the percentage of rainfall that runs off as stream flow on an event basis, (2) explore the relationship between rainfall intensity, antecedent moisture and percentage runoff, (3) establish physically based soil-moisture-accounting and infiltration parameter values for Moanalua Valley, (4) test the applicability of the DSA model in modeling a small rural Hawaiian watershed by defining and evaluating the model's assumptions and limitations, and (5) evaluate the DSA model's transferability potential for other Hawaiian watersheds.</p> <p>The report concluded that the model is successful in simulating the rainfall-runoff relationship in a small rural Hawaiian watershed. The average loss of rainfall to runoff is 35 percent, but if antecedent moisture conditions are relatively wet, between 45-60 percent of storm rainfall may run off. Conditions that affect runoff included the soil suction at field capacity, the saturated hydraulic conductivity, the rate of soil moisture redistribution within the layered soil system, and the proportion of pervious to impervious land surface.</p> <p>An increase in overland roughness values decreased peak flows. Therefore, it was concluded that major channelization projects, where the length of the channel is lined, would cause increased peak flows. The transferability of the model was considered plausible for other Hawaiian watersheds but is dependent upon the development of physically based soil-moisture-accounting and infiltration parameters.</p>		

Title:																	
Hydrology and Sediment Transport, Moanalua Valley, Oahu, Hawaii																	
Prepared By:	Prepared For:	Date															
Shade, Patricia J.	USGS	Sep 1984															
Description:																	
<p>The purpose and scope of this report was to analyze the rainfall-runoff relationship and sediment transport in Moanalua Valley. Rainfall, stream flow, and evaporation data as well as the physical characteristics of the basin were input into the Dawdy, Schaake, and Alley distributed routing rainfall-runoff model (DSA). Conducted under a cooperative agreement with the State of Hawai‘i, Department of Transportation as part of the scoping process for alternative alignments for the proposed H-3 Freeway.</p> <p>Methodology Data used in the study was collected from 1968 to 1980 from an extensive instrumentation system. Data was used in the DSA model to determine the percentage of rainfall that runs off as stream flow on an event basis. The study concluded that the model appears to be transferable to other Hawaiian watersheds. The analysis of suspended-sediment and bedload data from 1968-1982 used to determine basin sediment yield could be used as a basis for comparison and study in other Hawaiian watersheds.</p> <p>Findings/Recommendations The simulated hydrographs defined fairly accurately the very steep triangular shape of the flood flows observed in Moanalua. The indications were that on an event basis, the average estimate of runoff is 25 percent of rainfall. A basin water balance computed using calibrated model parameter values, indicates an average of 7 mgd of groundwater recharge.</p> <p>Sediment transport was determined from daily and intermittent suspended sediment samples collected at two sites, and from debris basin surveys. The estimated mean annual sediment yield ranges from between 500 and 1,050 tons per square miles per year. The estimate compares favorably to the calculated yields for other leeward O‘ahu basins. There is also a section on model assumptions – sources of error, and a basin water balance.</p>																	
<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th colspan="5" style="text-align: center;">Table 10. <u>Annual suspended-sediment discharge, in tons per year,</u> <u>at station 16227500, drainage area 0.94 mi²</u></th> </tr> <tr> <th style="text-align: center;">1973</th> <th style="text-align: center;">1974</th> <th style="text-align: center;">1975</th> <th style="text-align: center;">1976</th> <th style="text-align: center;">1977</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">23.04</td> <td style="text-align: center;">364.86</td> <td style="text-align: center;">83.12</td> <td style="text-align: center;">181.09</td> <td style="text-align: center;">26.04</td> </tr> </tbody> </table> <p>The mean annual subbasin yield equals 144 tons/mi²/yr.</p>			Table 10. <u>Annual suspended-sediment discharge, in tons per year,</u> <u>at station 16227500, drainage area 0.94 mi²</u>					1973	1974	1975	1976	1977	23.04	364.86	83.12	181.09	26.04
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1973	1974	1975	1976	1977													
23.04	364.86	83.12	181.09	26.04													
Comments																	
<p>The report appears to summarize a well-designed modeling exercise for sediment load and water budgeting for Moanalua Valley. A similar study for Kalihi Valley would be useful to establish how much sediment is received at Ke‘ehi Lagoon annually.</p> <ul style="list-style-type: none"> • Has there been any follow-up work with regard to sediment load transport? How will the report be used in the calculation of TMDL’s? Will the same model be used to establish TMDL’s? • How much development or alterations have taken place in Moanalua since the report was written? 																	

Title:		
Water Budget and the Effects of Land Use Changes on Ground Water Recharge, Oahu, Hawaii		
Prepared By:	Prepared For:	Date
Shade, P. J. and W. D. Nichols	USGS	1996
Description:		
<p>The purpose of this report was to describe the calculation of a predevelopment and a mid-1980's water budget for five major study areas on O'ahu. Additionally, the report attempted to describe the spatial distribution and temporal change in ground water recharge caused by changes in land use.</p> <p>Low- to medium-density urbanization increases the water available for evapotranspiration. Runoff increases and recharge may be reduced in wet areas, but recharge in dry areas may increase because of irrigation. Irrigated agriculture has the greatest effect on the water budget, increasing evapotranspiration but also recharging the ground water system.</p> <p>The report concluded that urbanization in southern O'ahu has led to an increase in estimated runoff of about 18 percent or 23 mgd. Irrigated agriculture resulted in an estimated increase in recharge of about 56 mgd for the entire area over predevelopment recharge.</p> <p>Increased urbanization for the entire island of O'ahu in the 1980's resulted in increased runoff of 22 mgd. Irrigated agriculture resulted in an estimated increase in evapotranspiration of 36 mgd in the 1980's. An increase in estimated recharge (88 mgd) in the 1980's was also attributed to irrigated agriculture.</p>		

Title:		
Kalihi-Moanalua Flood Hazard Area, Kalihi, Oahu, Hawaii, Map FP-8, Honolulu		
Prepared By:	Prepared For:	Date
DLNR – Division of Water and Land Development	DLNR – Division of Water and Land Development	May 1972
Description:		
<p>This write-up discusses basin descriptions, flood histories, flood problems, hydrology, and flood outlines. The maps illustrate the 50-year, 100-year, and standard project flood areas for the lower portions of Moanalua Stream and Kalihi Stream on a 1" = 200' scale. Flood problems are attributed to restrictions on stream capacity by Nimitz Highway and abandoned railroad bridges and the limited capacities of the existing stream channels. Flooding in the upper areas of Moanalua Stream is also attributed to inadequate bridge openings and the Ala Aolani Street culvert. The coastal plain is vulnerable to tsunami inundation although the hazard is considered small relative to the storm runoff hazard. Peak discharges at three points along Moanalua Stream and at the mouth of Kalihi Stream were computed. Flood profiles for the two streams are shown in figures 3-6.</p>		

Title:		
Flood Control and Flood Water Conservation in Hawaii, Volume I (revised): Flood Control and Flood Water Conservation in Hawaii, Circular C92		
Prepared By:	Prepared For:	Date
DLNR-Division of Water and Land Development	DLNR	Sep 1983
Description:		
<p>The purpose of this report is to provide a common understanding of the various aspects of flood control and therefore discusses flood control terminology and flood control strategies. Additionally, the report summarizes flood control damages and expenditures in Hawai'i and emphasizes the significance of flood control to the economy and to the public welfare and the need for improved methods of flood damage reporting. Also discussed are the roles of the State flood control agency, the functions of fighting units, flood disaster operations, and State-County relationships with regard to flood control matters. Several flood control measures were discussed. These include: (1) the regulation of land use through buffer zones, zoning ordinances, building codes, and urban renewal projects; (2) an efficient evacuation system for flood plains; and (3) the confinement of floods through the construction of levees and dikes, decreasing flood runoff, and improving channel capacity. Flood control measures should be selected based on the specific problems. The report briefly describes multi-purpose development including drainage, irrigation, water supply, storage, ground water replenishment, hydroelectric power, recreation, fish and wildlife conservation, and pollution abatement.</p>		

Title:		
Flood Control and Flood Water Conservation in Hawaii, Volume II (revised): General Flood Control Plan for Hawaii, Circular C93		
Prepared By:	Prepared For:	Date
DLNR-Division of Water and Land Development	DLNR	Sep 1983
Description:		
<p>This report updates the original Vol. II published in 1963. It includes background details on the general flood control plan including discussion of existing and planned flood control programs, completed control works for each island, and flood problem areas. A watershed identification code has been developed for Hawai'i. The report also includes analysis of available data on flood problem areas, recommendations to improve existing active and inactive flood control programs, and new programs. The Moanalua Stream Flood Control Project is an existing program. The report outlines existing conditions, the nature of the flood problem, past events, and the details of the existing program. Recommended measures include completion of Moanalua Stream flood improvements from Ke'ehi Lagoon to Moanalua Road, flood proofing school buildings above Moanalua Road, construction of two bridges across Manaiki Stream, improvements to Kahauiki Stream between Moanalua Road and the Moanalua Stream junction, and replacement of Kikowaena Street Bridge to allow greater flow.</p> <p>The Kalihi Stream Program is a planned program that attempts to mitigate coastal and transitional area flooding attributed to limited channel capacity and restrictive bridge openings. Existing conditions, a description of the flood problem, and previous improvements are outlined. The US COE conducted a survey report on the feasibility of Federal participation in flood control improvements for Kalihi Stream in 1975. The most practical and feasible solution was determined to be channel improvements in the lower reaches. This DLNR report recommends the realignment, widening, and improvements of Kalihi Stream from its mouth to approximately 8,400 feet upstream, and the organization of a Kalihi Valley Flood Fighting sub-unit to supplement the Honolulu unit.</p>		

Title:		
Flood Control and Flood Water Conservation in Hawaii, Volume III: Agencies and Legislation, Circular C94 (Revised)		
Prepared By:	Prepared For:	Date
DLNR – Division of Water and Land Development	Federal Emergency Management Agency	May 1994
Description:		
<p>The purpose of this project was to summarize agency flood control activities and to describe the programs and enabling legislation of each agency. Agencies include those on the federal level, the COE, the USDA-SCS, the Federal Emergency Management Agency, the USGS, and the National Weather Service; at the State level, the DLNR, the Soil and Water Conservation Districts, the State Civil Defense Agency, the Land Use Commission, and the Office of State Planning; and at the County level, the Departments of Public Works and in Honolulu, the Department of Land Utilization and Zoning Board of Appeals. Categories of flood control activities may include: data collection and interpretation, regulation of land use, flood prevention, and control projects. Flood relief activities may include flood emergency measures and repair and rehabilitation activities. The COE and the USDA-SCS project planning procedures are included as an Appendix.</p>		

Title:		
Post Flood Report: New Year's Eve Storm, December 31, 1987-January 1, 1988, Windward and Leeward East Oahu, Circular C-119		
Prepared By:	Prepared For:	Date
DLNR-Division of Water and Land Development	DLNR	Jul 1988
Description:		
<p>The purpose of this report is to document the New Year's Eve Storm of 1987, its intensity, its effects, the damage caused, and subsequent relief efforts. This report includes: (1) the climate before the storm, (2) the rainfall recorded in December 1987, (3) the meteorology of the storm, (4) landslides and debris flows, (5) the USGS's stream flow data and analysis, (6) major flood areas, (7) stream damages, (8) damage assessments and assistance, (9) agricultural losses, (10) the Soil Conservation Service's Emergency Stream Bank Protection Programs, (11) the USACE's estimate of repairs of Federal and local flood control projects, and (12) storm assistance by the Red Cross, the Salvation Army, and others. The only remedial efforts discussed were the SCS Emergency Stream Bank Protection Program to protect the exposed Kahawai, Waimānalo and 'Ōma'o Stream banks from erosion. No recommendations are made on flood control.</p>		

Title:		
Annual Report to the Twenty-First Legislature 2001 Regular Session on Act 152 SLH 2000 (HB 2835, HD2, SD2, CD1) “Relating to Watershed Protection”		
Prepared By:	Prepared For:	Date
DLNR	Hawaii State Legislature, 2001 Regular Session	Oct 2001
Description:		
<p>The Hawai‘i State Legislature passed Act 152 in the year 2000, which created a Watershed Protection Board to develop a watershed master plan to protect water resources. This master plan was to include: (1) identification of potential watershed management areas for protection; (2) criteria for eligible watershed management projects; (3) procedures and criteria for selecting eligible watershed management projects, (4) designation of watershed management projects and required funds; (5) an implementation plan for designated projects; (6) identification of potential funding sources (7) analysis of problems and issues encountered in the equitable levy, assessment, and collection of the watershed protection assessment in water users; and (8) any other issues. The board recommended: (1) focusing in on the ahupua‘a as the unit of planning with four phases: framework, watershed assessment and prioritization in the mauka areas, watershed master plan for the mauka areas, and watershed master plan for the mauka and makai areas; (2) the components of the management plan; (3) the identification of existing watershed partnerships; (4) two watershed assessment criteria, one based on resource values or conditions that impact water quality and quantity, and one that is based on the ability to deliver effective watershed protection programs; (5) criteria for eligibility be simple and easily understood; (6) the potential multi-million dollar cost is justified; (7) potential funding sources and the most equitable distribution of costs; (8) the use of the Conveyance Tax as a source of dedicated funding; (9) that a watershed protection assessment on all water users consider policy, legal, and equitable issues; (10) that the watershed assessment be based on a completed assessment and prioritization of watershed and water resource needs and an accountability plan for expending funds; and (11) a commitment to fund programs from all beneficiaries. Follow-up actions were also recommended.</p>		

Title:		
Water Resources Data, Hawaii and Other Pacific Areas, Water Year 2000, Vol. 1 Hawaii		
Prepared By:	Prepared For:	Date
Taogoshi, R., D. Nishimoto, R. Fontaine, M. Wong, and B. Hill	USGS	2001
Description:		
<p>The purpose of this report is to provide to interested parties data on the surface and groundwater resources of the State including (1) discharge records for 72 stream-gaging stations and 92 crest-stage partial record streamflow stations, (2) water quality records for 5 streamflow-gaging stations, and 28 partial-record streamflow stations, (3) water-level records for 87 observation wells, (4) water-quality records for 103 observation wells, and (5) accumulated rainfall records for 37 rainfall stations.</p> <p>There was substantial variation in streamflow during the 2000 water year, as observed from four index stations, one each on Hawai'i, Kaua'i, Maui, and O'ahu. Monthly mean flows at the four stations were below the long-term median monthly mean flows in October, November, February, March, and May and above the long-term median monthly mean flows in December, January, and September. Ground water levels at three continuously monitored observation wells did not change much from the levels recorded the previous year. Many of the observation wells throughout the state reached record low levels during the 2000 water year. Rainfall amounts in water year 2000 were below long-term normal amounts.</p>		

Title:		
Kalihi Stream Environmental Survey, Part I: Keehi Lagoon to King Street		
Prepared By:	Prepared For:	Date
Troutwine, Jack	COE	1972
Description:		
<p>This report documents the flora and fauna observed in and along Kalihi Stream and Kamaikai Stream from its mouth at Ke'ehi Lagoon to the Forest Watershed Boundary at the edge of the urban area. The survey results are described in five sections of the stream and include Ke'ehi Lagoon to King Street, King Street to School Street, School Street to Kamaikai Stream, Kamaikai Stream, and Kamaikai Stream Junction to Forest Watershed Boundary.</p> <p>Plants are listed in order of abundance with places of origin. Locations of plant clusters are indicated on rough sketches and cross sections. Some common plants include basket grass, Brazilian pepper, castor bean, elephant grass, finger grass, haole koa, mangrove, monkeypod, plum, seashore opiuma, palm grass, paspalum, and rose apple. Some endemic Hawaiian plants such as Hawaiian false mulberry, Hawaiian moonflower, and koa were found along the Stream. Native plant species found include hau, laua'e, hala, niu, kukui, nanea beach pea, popolo, and Hawaiian false ginger.</p> <p>Some common fauna include barred doves, Brazilian cardinals, bullfrogs, cardinals, catfish, crayfish, English sparrow, guppies, Freshwater snails, Japanese weather fish, Japanese white eyes, mongoose, mynahs, spotted dove, ricebirds, and toads. No endemic Hawaiian animals were found in the area.</p>		

Title:		
A Biological Report on Aliamanu Crater and Its Water Drainage to Keehi Lagoon		
Prepared By:	Prepared For:	Date
Troutwine, Jack	US Army Engineer Division, Pacific Ocean	Oct 1974
Description:		
<p>This report documents the flora and fauna observed in and along Aliamanu Crater and its drainage to Ke'ehi Lagoon. The crater is not currently inhabited by humans. Plants are listed in order of abundance with places of origin. Some common plants found in Aliamanu Crater include haole koa, kiawe, morning glory, and prickly pear cactus. Native plant species found include ilima and ti.</p> <p>Common fauna observed in the Crater include dogs, mongooses, barred doves, Brazilian cardinals, cardinals, house sparrows, Japanese white-eyes, mynahs, ricebirds, geckos, honey bees, millipedes, scorpions, skinks, and spiders. Cats and rats were not observed but are likely to exist in the area. The only native bird observed was the Kolea, or golden plover.</p> <p>Water from the crater empties into Salt Lake, the only natural lake on the island. Fauna found in and around the lake include tilapia, guppies, mollies, castle snails, ruddy turnstones, kolea, coots, Hawaiian ducks, and ae'o. Some common vegetation includes batis grass, kiawe, panic grass, natal red-top, and haole koa. Salt Lake drains into Moanalua Stream at an area that includes flora such as haole koa, Indian pluchea, desmanthus, sour bush, and mangrove.</p>		

Title:		
Draft Reconnaissance Report for Flood Control Moanalua Stream, Oahu, Hawaii		
Prepared By:	Prepared For:	Date
US Army Engineer District	US Army Engineer District	Mar 1979
Description:		
<p>Objectives of the report include (1) providing the initial assessment of problem identification, planning objectives, and schedule for the study of potential improvements to alleviate flooding on Moanalua Stream, O‘ahu, Hawai‘i, and (2) investigating the feasibility of flood damage reduction improvements to the extent that the Federal Government should participate in the construction of recommended solutions.</p> <p>Methodology of the study included an inclusive consultation approach with the local sponsor, the City and County of Honolulu Department of Public Works; community groups; private organizations; and relevant Federal, State, and local government organizations. A review of prior reports was included in the study process. The study followed guidelines established by the Water Resources Council, “Principles and Standards, National Environmental Policy Act, and Related Policies” (43 FR 30222-30253, 7 July 1978), pursuant to Section 103 of the Water Resources Planning Act (Public Law 89-80). The three steps in the development of the planning report are the reconnaissance study, intermediate plan development, and detailed plan development. A comparison is also made to national flood control objectives.</p> <p>Findings/Recommendations Section C of the study presents structural and non-structural measures for improvement. Topography, land availability, and economics limited the range of alternatives. Flood improvements are limited to a channel concept. Floodwall types include sheet piling and T-walls. Concrete invert lining, bank revetment, and floodwalls are being considered from Moanalua Freeway to Ke‘ehi Lagoon with emphasis on the west bank, to create a “controlled inundation” of the lands east of the stream, including Shafter Flats. Kahauiki Stream improvements were not considered in this plan. The study includes cost estimates for recommended actions.</p> <p>Comments The plan calls for a floodwall on the west bank, which leaves the east bank susceptible to increased flood damage. This action continues to limit the development potential of Fort Shafter Flats, which currently has plans to construct new facilities. Is the Army willing to provide some land from Shafter Flats to increase channel capacity? This would reduce the flood hazard for the lower reaches of the installation. The recommendations should consider permeable revetments. Several models of interlocking concrete blocks would allow for stream bank vegetation and infiltration of surface water.</p>		
		<p>Map showing extents of Flood Control Plan, between Ke'ehi Lagoon and Moanalua (H-1) Freeway.</p>

Title:		
Plan of Investigation for Flood Control and Allied Purposes, Kalihi Stream, Honolulu, Oahu, Hawaii		
Prepared By:	Prepared For:	Date
COE	COE	Jun 1971
Description:		
<p>The purpose of this plan is to outline the investigation of the flood control and water resource needs for the entire Kalihi Stream drainage basin. That investigation will determine the magnitude of the flood problem, the type and extent of improvements necessary to adequately satisfy the needs of the problem area, the potential for developing related water resource projects or activities, and the cost of possible alternative improvement plans.</p> <p>There were no existing Federal flood control improvements in the Kalihi Stream basin area at the time of the study. However, local government and private interests had constructed some concrete masonry walls along the lower reaches of the stream in increments from 1936 to 1960 for the purposes of flood control. Periodic removal of debris and silt had also occurred.</p> <p>The flood problem for Kalihi Stream is primarily confined to the low coastal lands and is attributed to limited capacity of the existing channel and restrictive bridge openings near the outlet. Some localized flooding also occurs on Kamaikai Stream, a tributary of Kalihi Stream. A flood in November of 1930 resulted in the loss of 14 lives and \$240,000 in damages. The high level of loss was attributed to dense urban development adjacent to the Stream. A flood of equal magnitude is expected to cause more damage because of increased development along the stream since 1930. Other problems associated with this Stream include its potential as a source of pollution of Ke'ehi Lagoon.</p>		

Title:		
Sand Island Shore Protection Detailed Project Report and Final Environmental Impact Statement		
Prepared By:	Prepared For:	Date
COE	DLNR	1989
Description:		
<p>The purpose of this report is to identify the cause and extent of erosion on Sand Island's southern shoreline, and to determine the feasibility in providing protective measures at the problem area. The report evaluated various features of the area including history and culture, physical setting, environmental setting, economic characteristics, and recreational resources.</p> <p>The report concluded that approximately 2,000 feet of the southern shoreline is unprotected against wave action due to partial or complete failure of the original revetment. Six alternatives were initially investigated to combat this problem. Nonstructural measures included vegetative stabilization and shoreline management, and structural measures included a bulkhead, a seawall, a revetment, or an offshore breakwater. The alternatives were narrowed to three for detailed assessment: a revetment plan, a seawall plan, and a plan that combined a revetment and seawall.</p> <p>The combination revetment and seawall alternative was recommended as the preferred plan based on a benefit-to-cost assessment, its response to associated evaluation criteria, and an assessment of how well it fulfills the planning objectives of the study including: preserving the natural tidepools of the study area, contributing to efforts to alleviate the shortage of beaches in central leeward O'ahu, and enhancing the recreational and educational opportunities in the study area. This plan includes rehabilitation of the existing revetment in Reach 1, the placement of three detached offshore breakwaters to protect the next 600 feet of shoreline, and the construction of 820 feet of stone revetment for the following 820 feet. Subsurface and offshore ground conditions are described in Appendix C and the typical cross-section for the revetment is illustrated in Figure 13. Some eroded areas inland of the revetment in Reach 3 will be reclaimed by backfilling with excavation spoils from other reaches in the shoreline.</p> <p>Based on recent observations, these shore protection recommendations were never implemented. This raises certain questions including: Why were the improvements never completed? What is the status of the erosion problem today? Are the recommendations still valid? What other techniques or measures (structural and nonstructural) could be explored? What are the impacts of erosion sediments on the near-shore habitat?</p>		

Title:		
Urban Flood Control Study, Honolulu, Hawaii. Final Reconnaissance Report		
Prepared By:	Prepared For:	Date
COE	COE	May 1992
Description:		
<p>The purpose for this reconnaissance report was to assess the condition and adequacy of the drainage systems in the east O‘ahu areas that were heavily damaged by the New Year’s storm of Jan. 1, 1988, and other O‘ahu locations. As flood control facilities are designed for traditional clear water flow, not for flow characteristics and problems created by landslides, debris flows, or high sediments loads, upstream flood control works are under-designed by as much as two orders of magnitude. Most of the focus is on Wailupe Stream and details regarding the further study, feasibility, and other considerations towards improving the drainage system in the Aina Haina area. The study area includes the West Honolulu Watershed.</p> <p>This report contains detailed geological, climatic and historic information about the WHWS project area. Report includes alternatives for plan development and implementation, a preliminary financial analysis, overall recommendations, a photographic record, and a bibliography.</p>		

Title:		
Erosion and Sediment Control Guide for Hawaii		
Prepared By:	Prepared For:	Date
USDA-SCS	USDA-SCS	1981
Description:		
<p>This report is a revision of the “Erosion and Sediment Control Guide for Urbanizing Areas in Hawaii,” published in 1976. It provides conservation measures for agricultural and urban lands and is intended to help farmers, ranchers, land use planners, urban developers, and others reduce erosion and sedimentation. The USDA SCS focuses on measures that provide protective ground cover and safe disposal of runoff. Control measures include those that are commonly used in Hawai‘i, although the guide stresses that each control or group of controls must be tailored to each specific site.</p> <p>There are three main categories of soil erosion: natural or geological; agricultural or forestry-related; and urban, municipal, and industrial development-related. Eleven basic erosion and sediment control principles are recommended for development: (1) select land with drainage patterns, total watershed runoff systems, topography, and soils that are favorable for the intended use; (2) schedule installation of permanent vegetation and infrastructure capable of safe storm runoff capacities before removing vegetative cover; (3) retain, protect, and supplement natural vegetation where feasible; (4) expose the smallest practical area of land at any one time; (5) expose land for the shortest practical period of time; (6) use temporary plant cover, mulching and/or structures to control runoff and protect erosion-prone areas during construction; (7) provide for increased runoff caused by altered soils and surface conditions; (8) remove heavy sediment loads from runoff waters by using debris, sediment, or catchment basins where needed and practical; (9) enhance development and reduce runoff by using trees, natural vegetation, and attractive physical features; (10) avoid developments in flood plains, natural water courses, and constructed channels; and (11) ensure regular maintenance of conservation practices and/or measures.</p> <p>The appendices include guides to “Estimating Soil Loss” and “Estimating Runoff,” and a list of plants suitable for erosion control, conservation, and beautification.</p>		

Title:		
Manaiki Stream Flood Control Project Ala Mahamoe Street to Mahiole Street, Moanalua, Honolulu, Oahu, Hawaii		
Prepared By:	Prepared For:	Date
William Hee and Assoc.	CCH Department of Public Works	1979
Description:		
<p>The purpose of this assessment is to describe several alternative solutions to erosion and inundation as a result of flood events. Flooding is not expected to result in life hazards in this area, but there is the potential for property damage, including erosion to 10 to 12 backyards and inundation of several homes and a church, up to one foot, along the 3,000-foot project length.</p> <p>The report discusses related projects in the vicinity. Also, four bank erosion alternatives were studied: (1) do nothing, (2) complete channelization, (3) partial channelization, and (4) selected bank protection. Three inundation solutions were considered: (1) do nothing, (2) initiate a maintenance program, and (3) enlarge the bridge/culvert.</p> <p>The City proposed segmented walls to protect the stream banks at about five critical locations to minimize erosion during flooding and enlargement of the bridge/culvert at Mahiole Street to minimize inundation impacts. Costs were estimated at \$750,000 for bank stabilization and \$350,000 for the bridge/culvert enlargement.</p>		

Title:		
Estimation of Magnitude and Frequency of Floods for Streams on the Island of Oahu, Hawaii		
Prepared By:	Prepared For:	Date
Wong, Michael F.	USGS	1994
Description:		
<p>The purpose of this report is to estimate the magnitude and frequency of floods for unregulated streams at stream gage sites on O‘ahu. Additionally, the report seeks to identify techniques that can be used to estimate the magnitude and frequency of streams at ungaged sites. This information is needed to adequately design bridges, flood control structures, and buildings located in or adjacent to flood plains. The report also includes a description of the island, previous rainfall/flood studies, annual peak discharge data, flood frequency data, and drainage basin and climatic characteristics computed by GIS.</p> <p>The report concluded that most estimates from the regression equations in this study are lower than the peak-discharge estimates based on previous studies.</p>		

Title:		
Baseline Quality Data for Kalihi Stream, Technical Report No. 71		
Prepared By:	Prepared For:	Date
Young, Reginald H. F. and Gordon K. Matsushita	UH WRRC	Jun 1973
Description:		
<p>The purpose of this study was to establish baseline data for Kalihi Stream and to determine changes in stream water quality in relation to land use patterns during average and peak stream flows under daily and seasonal variations. This report includes data regarding physical, chemical, and bacteriological parameters; rainfall and stream discharges; pollution loads and pesticide; and heavy metal content. Dry weather conditions tended to reflect more human fecal contamination than wet weather, which exhibits a predominance of animal wastes. Overall stream water quality for both wet and dry flows was comparable to that for other Hawai‘i streams and in the same order of magnitude as streams in the rest of the United States and other countries. Parameter concentrations and pollution loads increased downstream in both dry and wet weather conditions as development, land use activity, population, and housing density increase. Ke‘ehi Lagoon, which Kalihi Stream feeds into, is classified as Class A Waters, or those used for recreational purposes. The Ke‘ehi Lagoon marina area is designated as Class B Waters, used for small boat harbors, commercial, shipping, and industrial activities; bait fishing; and aesthetic enjoyment. Kalihi Stream is classified as Class 2 Waters, which are used for recreation, aquaculture, agriculture, industrial supply, and aquatic biota propagation. Fecal and total coliform densities exceeded Class 2 Standards, although these standards were established without baseline data. Nutrient Standards (Total Nitrogen and Total Phosphorous) for Class A Waters were exceeded during wet and dry weather periods. There were no State or Federal standards for pesticide levels in fresh or coastal waters at the time of the study, but there were no significant pesticide concentrations. Recommendations include a re-evaluation of the State Water Quality Standards (Chapter 37-A, Public Health Regulations), which were established without prior investigation of existing conditions.</p>		