TERRA / GeoPentech
a Joint Venture

Technical Memorandum

DRAFT

Date: April 5, 2024

To: Paul Sellier, PE, Water Resources Director - MMWD

From: Guilaine Roussel, PE, Project Manager - TGP

Subject: ***Results of Alternatives Screening***
Water Supply Storage Improvements

This technical memorandum summarizes the results of the development and screening of alternatives associated with investigation of storage improvements for Marin Municipal Water District (Marin Water).

1.0 INTRODUCTION AND BACKGROUND

The joint venture team of TERRA Engineers, Inc. and GeoPentech, Inc. (TGP) was selected by Marin Water to evaluate alternatives to increase water storage and facilitate the identification of one or more projects for further study. The TGP Team subconsultants include InfraTerra, Integrated Engineering & Construction, Panorama Environmental, COWI North America, Water Resources Engineering, and Cinquini & Passarino.

Marin Water's goal is to develop additional storage to enhance the reliability, flexibility and resiliency of the water system, consistent with the Strategic Water Supply Assessment (SWSA, May 2023). Prepared in response to recent drought conditions that severely threatened water supply reliability, the SWSA included an assessment of current and future hydrological conditions, performance of the Marin Water system under these conditions, consideration of strategies and concepts, and development of a water supply resiliency roadmap. The roadmap includes development of an additional 20,000 acre-feet (AF)[1] of local storage.

The alternatives evaluation summarized in this memo builds on the investigations completed for the SWSA and focuses on further development and evaluation of solutions that capture and store surface water within Marin County. Ten (10) storage alternatives were identified and briefly described in the SWSA and served as a starting point for work by TGP.

The first element of work by TGP consisted of the systematic development of the ten identified alternatives, and the formulation of additional alternatives and/or combinations of solutions, as appropriate. The team developed information on various aspects of each alternative including storage volume, reliability, approximate volumes of earthwork and other major construction items, geotechnical and geologic considerations, constructability, incremental inundation area, land use compatibility and environmental considerations, Rough Order of Magnitude (ROM) costs, and time for implementation. This information was reviewed in a collaborative workshop which used the information about each alternative to evaluate the alternatives against the following screening criteria: (a) water reliability and sustainability; (b) flexibility and resiliency; (c) schedule and implementation; (d) water quality; (e) environmental and social stewardship; and (f) economic and financial feasibility.

[1] Marin Water will confirm the amount of storage capacity needed as planning and design progress.

The following three sections of this memorandum provide a brief description of the alternatives considered, evaluation of each alternative against the above screening criteria, and a summary and the identification of the top alternatives to be further evaluated.

2.0 DESCRIPTION OF ALTERNATIVES

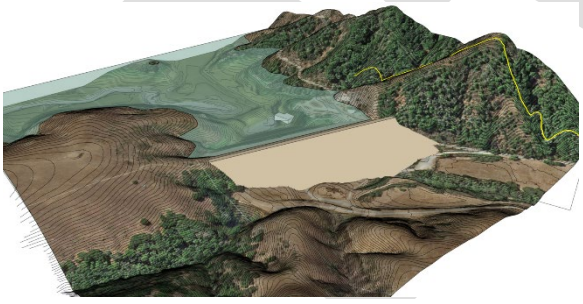
Twelve alternatives were specifically considered by TGP: the ten (10) that were included in the SWSA and two (2) new alternatives that were developed during the course of the work. The categories and names of the alternatives considered are as follows and each is briefly described in this section.

Dam Raises	New Dams	Spillway Modifications	Others
Soulajule	Halleck	Soulajule	Nicasio Dredging
Nicasio	Devil's Gulch	Nicasio	
Kent	Upper Nicasio (New)	Kent	
Alpine (New)		Alpine	

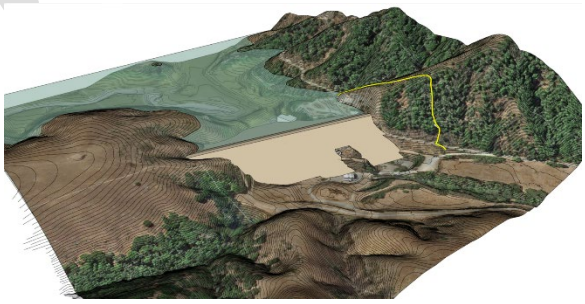
2.1 Soulajule Raise

Soulajule Dam is located on Arroyo Sausal Creek in unincorporated western Marin County north of the town of Point Reyes Station. The dam, built in 1979, is a zoned earth fill dam, approximately 122 feet high and 700 feet long. The dam impounds Soulajule Reservoir, which has a normal maximum storage capacity of approximately 10,300 acre-feet.

Raising the dam nominally 39 feet would provide an additional storage of about 20,000 acre-feet. Two options were considered for the raise: one placing the additional fill on the downstream side of the existing dam, the other placing the new fill symmetrically on both the upstream and downstream sides. Both options would require rebuilding the spillway into the left abutment and each has advantages and disadvantages. The two options are shown below.

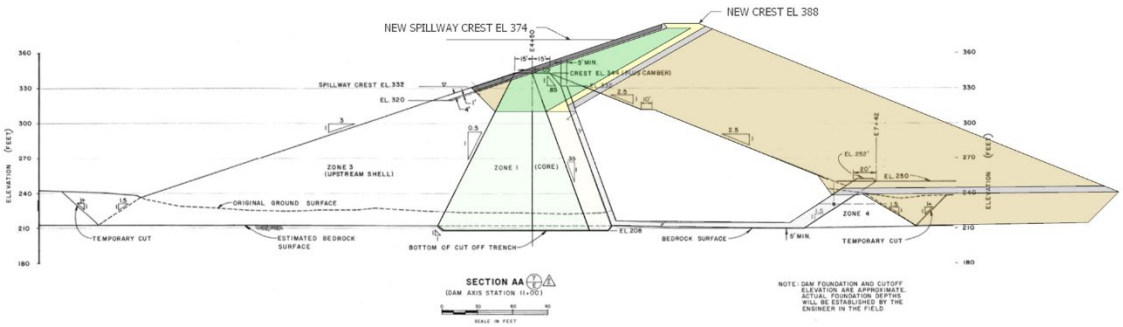


Downstream Raise

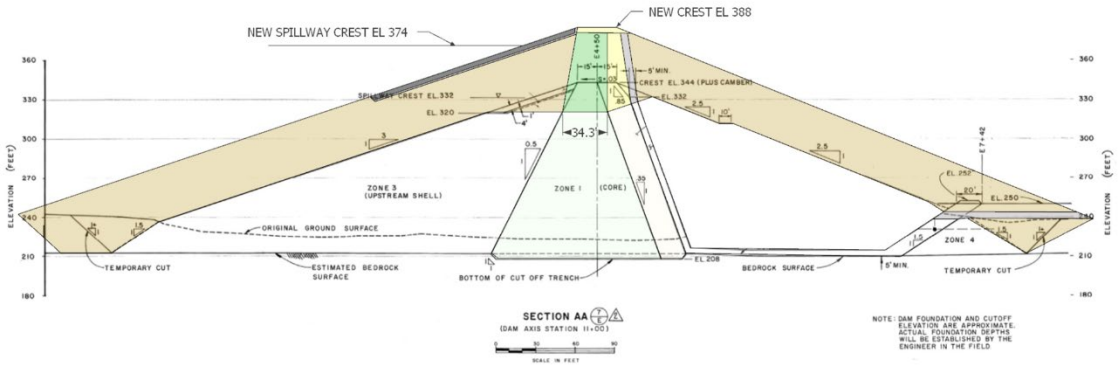


Upstream and Downstream Raise

The downstream raise moves the axis of the dam significantly downstream and would require a somewhat complicated zoning and the rebuilding of the pump station. This option might not require draining the reservoir during construction. The upstream/downstream raise option maintains the axis of the dam at its current location but may require alteration or replacement of the upstream intake structure. It would also require draining the reservoir during construction. Schematic cross sections for the two options are shown on Page 3. Quantities of required new fill are 1.7 million cubic yards (M cy) and 1.2 M cy for the downstream and upstream/downstream raise, respectively.



Downstream Raise

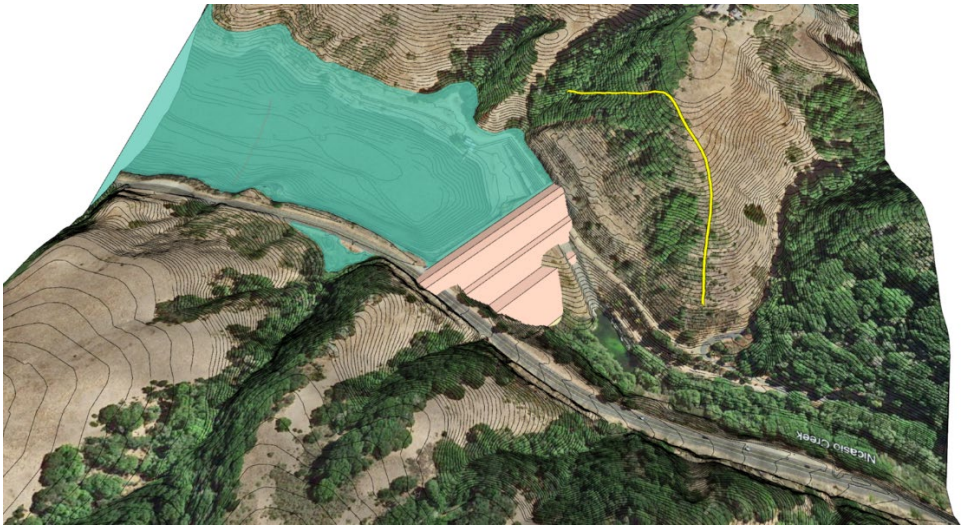


Upstream and Downstream Raise

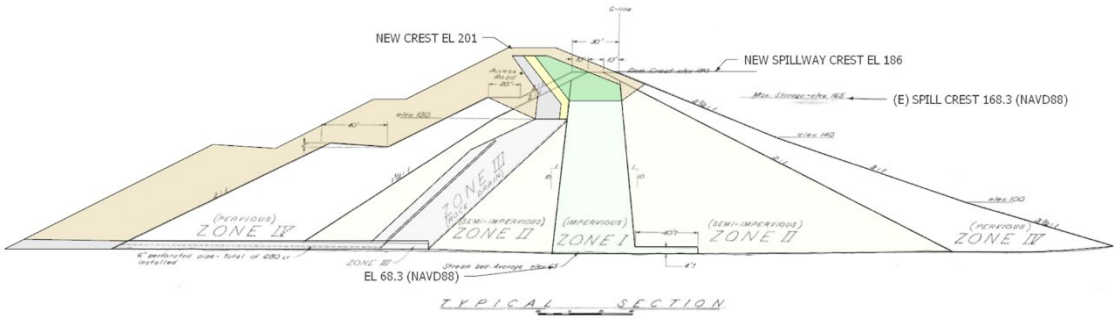
The potential reservoir expansion area includes land owned by Marin Water and privately owned land. The existing reservoir and dam are surrounded by agricultural land (typically used for grazing) and forest land (hardwood with patches of conifer). There are six or more building complexes within the new spill crest elevation, some of which include residences. Affected infrastructure includes Arroyo Sausal Road and private roads.

2.2 Nicasio Raise

Nicasio reservoir is in unincorporated Marin County near the town of Nicasio and is impounded by Seeger Dam. The dam is a zoned earth and rockfill dam that was completed in 1961. The dam is approximately 115 feet high with a crest length of 400 feet. Nicasio Reservoir has a maximum storage capacity of approximately 20,700 acre-feet. –



Raising the dam by 18 feet would provide an additional storage of about 20,000 acre-feet. The raise would require building a new spillway in the left abutment but would only require about 180,000 cy of new fill.



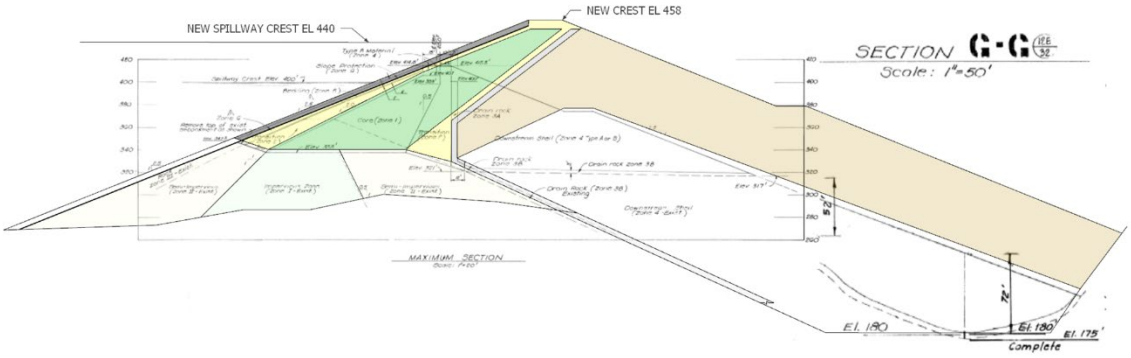
The potential reservoir expansion area includes land owned by Marin Water and privately owned land, including the town of Nicasio. The existing reservoir and dam are surrounded by agricultural land with relatively few structures and limited forested areas; affected infrastructure includes Pt. Reyes - Petaluma Road, Nicasio Valley Road, and private roads.

Protecting the town from flooding would necessitate a 40-foot-high, 900-foot-long dike and a 2.6-mile diversion of Nicasio and Halleck Creeks around the eastern portion of the reservoir. A diversion of inflow from 3 drainage channels flowing from the north would also be required. Construction of these diversions, each with its own diversion dam, intake, and flood pool area, is likely to be very complicated given the existing infrastructure. The alternative would also require reconstruction of almost 8 miles of roads.

2.3 Kent Raise

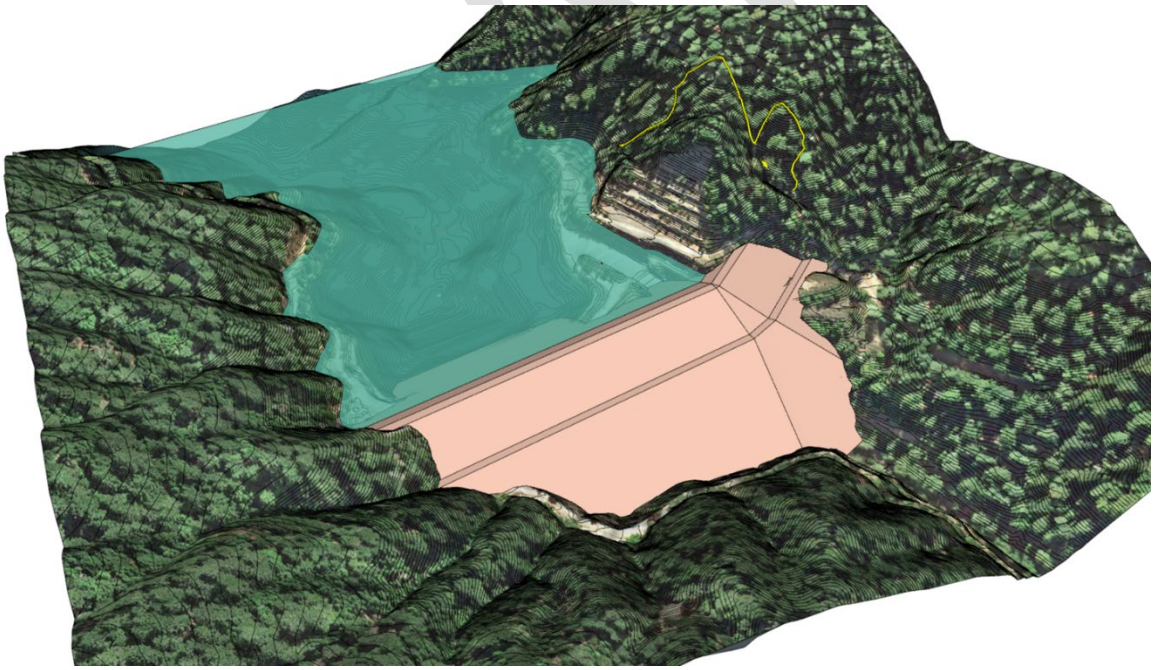
Kent Reservoir is in unincorporated Marin County near the communities of Lagunitas and Forest Knolls and is impounded by Peters Dam. The dam is a zoned earth and rockfill dam that was originally completed in 1953. The dam was raised during 1980 and 1981. The raise was also a zoned embankment dam. The dam is approximately 230 feet high with a crest length of 700 feet. The dam retains Kent Reservoir, which has a maximum storage capacity of approximately 33,300 acre-feet. Kent Reservoir is within watershed land managed by Marin Water. Most of the land surrounding the existing reservoir and dam is forested (a mix of conifer and hardwood). There are numerous publicly accessible trails in the area.

Raising the dam about 37 feet would provide additional storage of about 20,000 acre-feet. The raise would require removal of a substantial portion of the existing embankment to expose the various zones that need to be extended in the new embankment in a way that maintains their integrity.



The crest of the new dam would be moved downstream, and a curved embankment would be necessary to tie into the left abutment while avoiding a side valley. The raise would also require building a new spillway in the left abutment that may have to be curved.

The amount of new fill required for the raise is about 2.9 M cy.



2.4 Alpine Raise

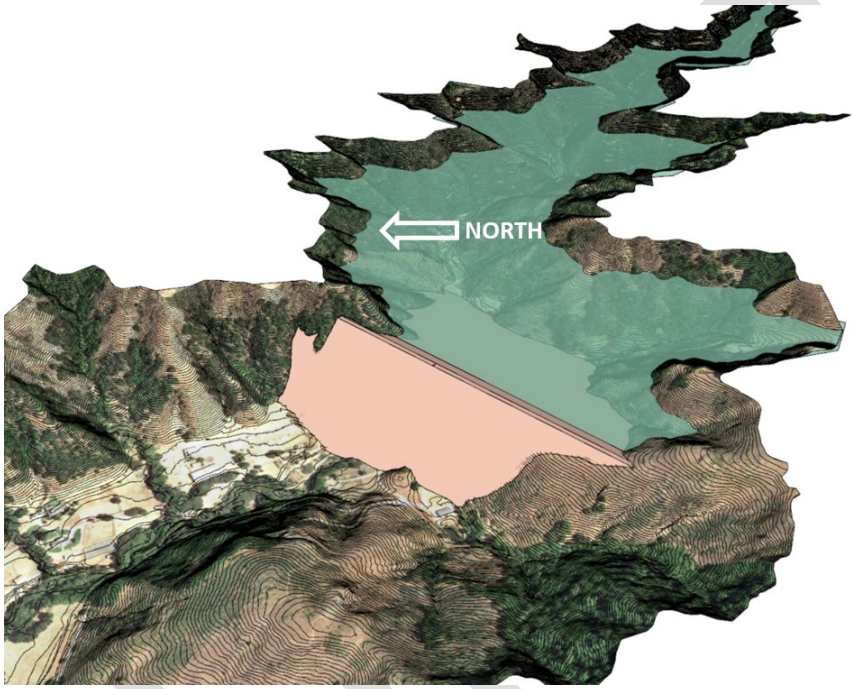
Alpine Reservoir is in unincorporated Marin County on Lagunitas Creek in the Mount Tamalpais Watershed, immediately downstream of Bon Tempe Reservoir. Alpine Dam is a concrete arch gravity dam that was originally completed in 1919 and then raised in 1941. The dam is approximately 137 feet high with a crest length of 700 feet. The dam impounds Alpine Reservoir which has a maximum storage capacity of approximately 8,891 acre-feet. Most of the land surrounding the existing reservoir and dam is forested (mostly conifer). There are numerous publicly accessible roads and trails nearby, including the Fairfax-Bolinas Road which crosses Alpine Dam.

Steps were left in the downstream face of the dam when it was raised in 1941 to allow another raise of the dam at a later date. Raising the dam by about 78 feet and bringing the maximum operating level to match that of Bon Tempe Reservoir would provide an additional 24,000 acre-feet of storage. Bon Tempe Dam would be breached, and the two reservoirs would be operated as one. The raise would also require the construction of a small saddle dam in a canyon to the north to protect the Meadow Club from flooding. Also, the spillway would have to be rebuilt as part of the dam raise. Of special concern is a large ancient landslide on the eastern side of the reservoir that would have to be considered if the alternative is further advanced.

The amount of new material required for the raise would be 246,000 cy of concrete for the dam and 200,000 cy of fill for the new saddle dam.

2.5 Halleck Reservoir

The new Halleck Reservoir would be located on Halleck Creek in unincorporated Marin County east of the town of Nicasio and about 3 miles east of Nicasio Reservoir. The Halleck dam and reservoir site is within the Nicasio Reservoir watershed off Old Rancheria Road; land uses include agricultural and forest (mostly hardwood) land. There are numerous structures associated with an equestrian facility, at least one residence, and private roads within the potential dam and reservoir site. A 278-foot-high, 2,200-foot-long zoned earth and rockfill dam would impound a 20,000-acre-foot reservoir.

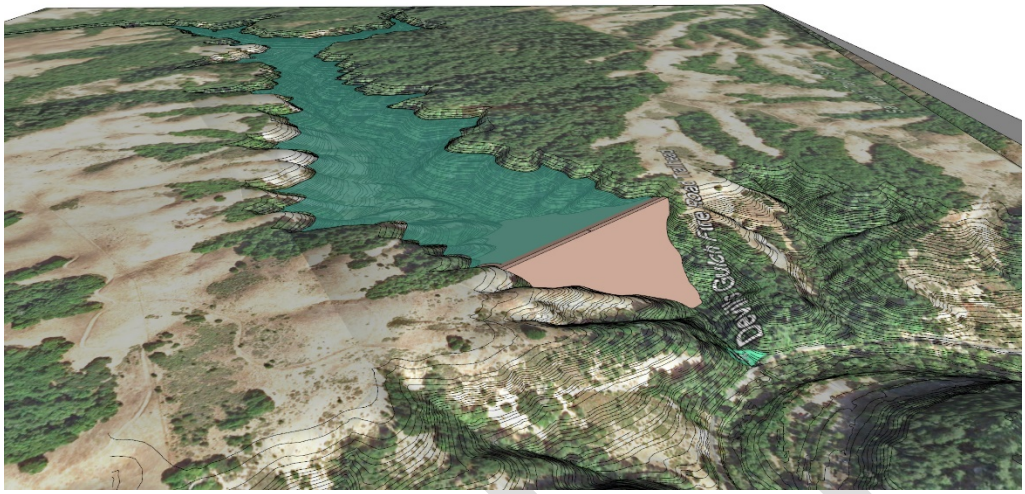


Construction of this new dam would require about 10.4 M cy of fill.

2.6 Devil's Gulch Reservoir

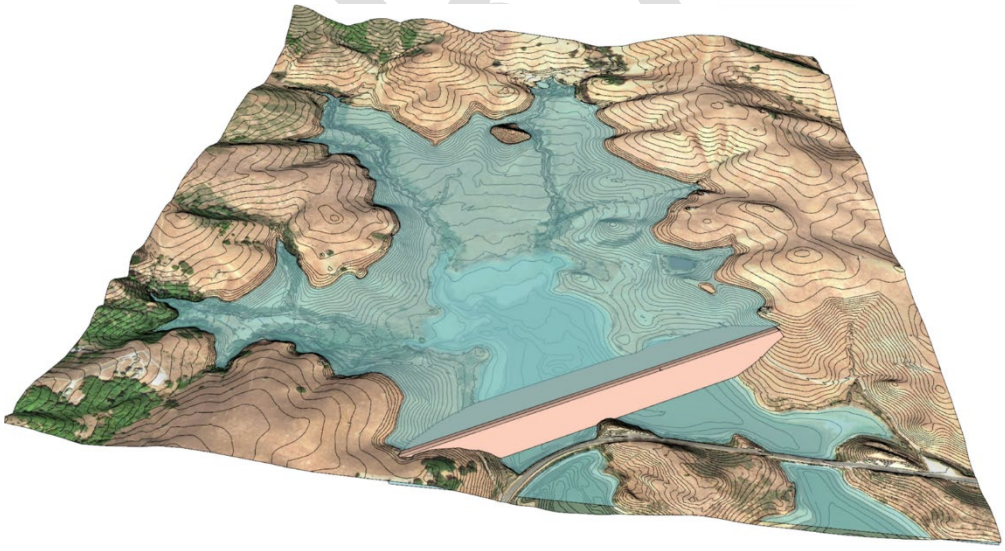
The Devil's Gulch reservoir and dam site is in a narrow canyon off Sir Francis Drake Boulevard, about 3 miles north of Kent Reservoir. The site is within state- and federally-owned land that is part of Samuel P. Taylor State Park and the Golden Gate National Recreation Area. The area is forested open space used for recreation (trails, campground). A 270-foot-high,1,400-foot-long zoned earth and rockfill dam on Devil's Gulch Creek, a tributary to Lagunitas Creek, would impound a 20,000-acre-foot reservoir.

Construction of this new dam would require about 3.6 M cy of fill and necessitate work in a space-constrained area in the vicinity of Sir Francis Drake Boulevard.



2.7 Upper Nicasio Reservoir

The Upper Nicasio Reservoir would be in the northwestern portion of the existing Nicasio Reservoir watershed, to the north of Point Reyes-Petaluma Road. Existing uses include agricultural (ranch) land, several building complexes including residences, and private roads. The new 20,000-acre-foot upper reservoir would be impounded by a 103-foot-high, 3,900-foot-long zoned earth and rockfill dam. The new dam would be constructed immediately north of Point Reyes-Petaluma Road to allow continued use of the road during construction. Construction of the new dam would require about 4.8 M cy of fill.



2.8 Spillway Modifications

Spillway modifications considered for this investigation consist of installing either moveable gates or fixed "flashboards" to incrementally raise the reservoir storage elevation without modifying the dam. None of the

spillway modifications on its own could achieve Marin Water's goal of providing substantial additional storage. However, the spillway modifications could provide additional temporary or permanent storage and can be constructed faster than any of the alternatives that require raising an existing dam or building a new dam.

2.8.1 Nicasio (Seeger) Dam

Nicasio (Seeger) dam is different from the other three existing dams because potential spillway gates were considered in the original design of the dam and spillway when the dam was designed in the late 1950's. The dam was built with enough freeboard to allow the addition of 3-foot-high flashboards, thereby permanently raising the spillway level without having to modify the dam or construct additional flood protection features near the town of Nicasio. This modification to the existing spillway would provide an additional 3,000 acre-feet of permanent storage to Nicasio Reservoir.

2.8.2 Soulajule and Kent (Peters) Dams

Soulajule and Peters Dams have spillways that could accommodate gates along their weirs. however, freeboard is relatively limited and would preclude installation of fixed gates.

Moveable gates could be bladder gates that would be raised after the winter months to capture additional inflow from April through October. However, these gates would have to be lowered in advance of storms when the reservoir level is at the top of the raised gates.

The addition of moveable gates at Soulajule and Kent could provide 1,200 and 1,800 acre-feet of temporary additional storage, respectively.

2.8.3 Alpine Dam

The spillway system at Alpine Dam has 8 self-priming siphons built inside the concrete dam that release water on the downstream face of the dam. Moveable gates on this dam could be knife gates installed in front of the opening of each of the siphon spillways. This installation would require the use of a barge in the reservoir after lowering the reservoir level below the bottom of the siphon openings. As with the spillway modifications for Soulajule and Peters Dams described above, the gates at Alpine Dam would be closed after the winter season to capture additional inflow from April through October and raised in advance of summer storms to open the siphon spillways.

The addition of moveable gates at Alpine Dam may provide 900 acre-feet of additional temporary storage.

2.9 Dredging of Nicasio Reservoir

The dredging of 32.3 M cy of materials from Nicasio Reservoir would provide an additional 20,000 acre-feet of additional storage within the reservoir. This approach would require the use of barge(s) on the reservoir and the excavated materials would have to be temporarily stored on site, dewatered, loaded into trucks, and transported off-site for disposal. Marin Water's use of the reservoir would be impaired during the dredging operation and the natural inflow into the reservoir would have to be somehow diverted so the reservoir did not spill and cause adverse water quality downstream.

3.0 ALTERNATIVE SCREENING

The following criteria were used in the screening of the alternatives: (a) water reliability and sustainability; (b) flexibility and resiliency; (c) schedule and implementation; (d) water quality; (e) environmental and social stewardship; and (f) economic and financial feasibility. The following considerations were qualitatively assessed during the screening exercise.

Water Reliability and Sustainability	Does the alternative meet the goal to develop additional storage? What is the yield in acre-feet? Are there substantial technical risks that threaten the alternative's technical or economic feasibility?
Flexibility and Resiliency	Does the alternative integrate well with Marin Water's operations? Is the alternative flexible to work over a range of future scenarios? Is the alternative's performance relatively insensitive to future uncertainty?
Schedule and Implementation	Are there substantial concerns regarding constructability or compatibility with existing land uses?
Water Quality	Would managing water quality of downstream releases during construction pose challenges?
Environmental and Social Stewardship	Alternatives not screened out at this stage will receive detailed study in the next phase of work.
Economic and Financial	Is the alternative cost-effective, i.e., economically feasible considering its benefits relative to its likely costs? Is the alternative affordable, i.e., financially feasible?

The screening process culminated in a cooperative workshop with input from representatives of Marin Water, Woodard & Curran, Environmental Science Associates, and the TGP Team. The results of the screening are summarized in Table 1.

TABLE 1 – SCREENING OF ALTERNATIVES

Alternative	Screening Criteria					
	Water Reliability and Sustainability	**Flexibility and Resiliency**	**Schedule and Implementation**	**Water Quality**	**Environmental and Social Stewardship[2]**	**Economic and Financial Feasibility**
Soulajule Raise	The alternative can meet the goal of adding substantial local storage. Technical risks are low and this alternative is relatively favorable from a geotechnical standpoint, and a water reliability and sustainability perspective.	The alternative integrates well with the current operations of Marin Water. Based on the largely passive capture of surface water and large watershed, the performance of this alternative is relatively insensitive to future uncertainty. The reservoir could reasonably serve as an endpoint for imported water should the Water Conveyance Improvements Project be implemented. [3]	Constructability is favorable compared to other alternatives and there are no clear obstacles to developing a typical construction schedule. The expanded reservoir would inundate parcels with agricultural land and structures including residences and roads. If this alternative moves forward, measures to reduce inundation or otherwise protect structures would be evaluated.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir. Water quality for downstream releases during construction must be considered.	There would be effects on biological resources including steelhead, coho salmon, and California red-legged frog and their critical habitat and Baker's larkspur; wetland and riverine features, forested riparian, and sensitive natural communities would be lost/inundated. The alternative would adversely affect architectural resources and would require detailed study.	The alternative is ***potentially economically feasible***. The alternative appears ***financially feasible***.
Nicasio Raise	The alternative can meet the goal of adding substantial local storage. Technical risks for a dam raise are low and the alternative is relatively favorable from a geotechnical standpoint. However, technical risks for protecting the town of Nicasio from inundation are high because of the complexity and extent of the required measures given the existing infrastructure.	The alternative integrates well with the current operations of Marin Water. Based on the largely passive capture of surface water and large watershed, the benefits afforded by this alternative appear relatively insensitive to future uncertainty. The reservoir could reasonably serve as an endpoint for imported water should the Water Conveyance Improvements Project be implemented.	Constructability is favorable compared to other alternatives and there are no clear obstacles to developing a typical construction schedule. The expanded reservoir would inundate parcels with agricultural land, few structures, and roads. This alternative includes extensive dikes to protect the town of Nicasio, and channelization of Halleck and Nicasio creeks to passively direct water around the town and into the reservoir. Design and permitting would likely hinder timely implementation.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir. Water quality for downstream releases during construction must be considered.	There would be effects on biological resources including coho salmon and their associated critical habitat, Steelhead, Western bumblebee and Western pond turtle; wetlands and riverine features, forested riparian, and sensitive natural communities would be lost/inundated. The alternative would likely adversely affect archaeological (e.g., multiple habitation sites) and architectural resources and would require detailed study.	The alternative is ***not economically or financially feasible*** because of the protection measures required to avoid flooding the town of Nicasio.

[2] Indicates list of initial environmental and social issues to be investigated for alternatives that are not screened out during this phase. Refer also to Schedule and Implementation information regarding future evaluation of areas that would be inundated.
[3] Marin Water is currently investigating the feasibility of a project to convey additional water from Sonoma County Water Agency (SCWA), consistent with the SWSA roadmap. One of the constraints to use of the SCWA contracted water supply is the inability to convey water to storage. Marin Water is investigating construction of a pipeline(s) to convey water from SCWA to Soulajule and/or Nicasio reservoir.

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Kent Raise	The alternative can meet the goal of adding substantial local storage. Technical risks are high: the dam zoning is complex, and a new spillway would be a relatively difficult undertaking and fill availability is unbalanced with clay core material needing to be imported and requiring a long haul. Water reliability is lower than similar alternatives and sustainability is adequate.	The alternative integrates well with the current operations of Marin Water. Based on the passive capture of surface water and large watershed the alternative should have some flexibility to fit in the range of future scenarios. The reservoir would not be able to receive imported water, should the Water Conveyance Improvements Project as it is currently contemplated be implemented. Consequently, the resilience of this alternative would be incrementally less than other alternatives.	Northern spotted owls (NSOs) nest near Peters Dam; construction of the earth and rockfill dam would be limited during nesting season. Loss of habitat for listed species would likely require replacement. These factors would prolong the construction duration and increase cost and implementation complexity. Environmental permitting would likely hinder timely implementation. Marin Water owns the area that would be inundated by the future reservoir, which includes trails and publicly accessible roads.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir. Water quality for downstream releases during construction must be considered.	There would be effects on biological resources, including Northern Spotted Owls (NSO) which nest in mature conifer forests; and steelhead, coho salmon, and their critical habitat. NSO nest sites occur near the dam construction area and areas to be inundated. Several other special-status species known to occur in the immediate vicinity could also be affected. Wetland and riverine features, forested riparian, and sensitive natural communities (including mature conifer forest) would be lost/inundated. The potential to encounter important cultural resources is considered low (there are no undocumented buildings, complexes or structures and no recorded archaeological resources).	The alternative may be ***economically* infeasible** due to construction limitations and increased cost associated with habitat replacement. The alternative is otherwise considered ***potentially financially feasible.***
Alpine Raise	The alternative can meet the goal of adding substantial local storage. Technical risks are moderate, the dam and dike construction are straightforward, but the new reservoir level would interact with a very large historic landslide which would require special study. Water reliability is lower than similar alternatives and sustainability is adequate.	The alternative integrates well with the current operations of Marin Water but would require some special considerations for taking Bon Tempe reservoir out of service while keeping the pump station active. Based on the passive capture of surface water and relatively large watershed this alternative should have flexibility to fit in the range of future scenarios but may require upstream pumping of surplus water from Kent Reservoir. The reservoir would not be able to receive imported water, should the Water Conveyance Improvements Project as it is currently contemplated be implemented. Consequently, the resilience of this alternative would be incrementally less than other alternatives.	NSOs nest near the dam; construction would be limited during nesting season. Loss of habitat for listed species would likely require replacement. These factors would prolong the construction duration, increase construction cost and increase implementation complexity. Environmental permitting would likely hinder timely implementation. Constructability is straightforward assuming that aggregate can be obtained locally. The dike construction may require a long-haul of fill material and there may be other environmental obstacles that could complicate the construction process from a scheduling standpoint. Marin Water owns the area that would be inundated by the reservoir expansion, which includes trails and publicly accessible roads.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir. Water quality for downstream releases during construction must be considered.	There would be effects on biological resources, including NSO and their critical habitat; nest sites occur near the dam construction area. Suitable habitat for Western pond turtle could also be affected. Several other special-status species that occur in the immediate vicinity could also be affected. Wetland and riverine features, forested riparian, and sensitive natural communities (including mature conifer forest) would be lost/inundated. The potential to encounter important cultural resources is considered low (there are undocumented buildings, complexes and structures in the area but no recorded archaeological resources).	The alternative is ***not economically feasible*** even though it has somewhat lower uncertainty than others because land acquisition is not a factor. The mass concrete driving the overall cost to an unreasonable range and lower-cost alternatives (e.g., roller-compacted concrete) are not considered constructable given the limited construction window and there is increased cost associated with habitat replacement. The alternative is ***not financially feasible.***

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	Water Reliability and Sustainability	**Flexibility and Resiliency**	**Schedule and Implementation**	**Water Quality**	**Environmental and Social Stewardship[2]**	**Economic and Financial Feasibility**
Halleck Reservoir	The alternative can meet the goal of adding substantial local storage. Technical risks are high, and the alternative is relatively unfavorable from a geotechnical standpoint due to questionable foundation conditions, geologic hazards, and the height of the dam (278 feet).	The alternative integrates well with the current operations of Marin Water. It is unlikely that the reservoir could be operated as a self-filling, passive system. However, flexibility could be achieved with pump stations or conveyance systems to utilize the storage capacity. The reservoir storage would serve as a reasonable endpoint for imported water should the Water Conveyance Improvements Project be implemented or surplus surface water within the Marin Water system. .	Constructability is favorable compared to other alternatives and there are no clear obstacles to developing a typical construction schedule. The expanded reservoir would inundate parcels with agricultural land, structures associated with an equestrian facility, and at least one residence.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir. Water quality for downstream releases during construction must be considered.	There would be effects on biological resources including wetlands and riverine features, forested riparian, and sensitive natural communities that would be inundated. Little information is publicly available regarding the presence of special-status species. The potential to encounter important cultural resources is considered low (there are undocumented buildings, complexes and structures in the area but no recorded archaeological resources).	The alternative is ***not economically feasible*** based on the very large embankment required and subsequent extreme construction costs. The alternative is ***not financially feasible***.
Devil's Gulch Reservoir	The alternative can meet the goal of adding substantial local storage. Technical risks are low, and the alternative is relatively favorable from a geotechnical standpoint.	The alternative integrates well with the current operations of Marin Water, although substantial conveyance facilities would be needed. It is unlikely that this reservoir could be operated as a self-filling, passive system. However, flexibility could be achieved with pump stations or conveyance systems to utilize the storage capacity. The reservoir would not be able to receive imported water, should the Water Conveyance Improvements Project as it is currently contemplated be implemented. Consequently, the resilience of this alternative would be incrementally less than other alternatives.	This alternative would require acquisition and conversion of state- and federally-owned land within Samuel P. Taylor State Park and the Golden Gate National Recreation Area. Acquisition and conversion of state and federally owned land to reservoir storage, given the existence of other viable alternatives, is considered ***infeasible***.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir. Water quality for downstream releases during construction must be considered.	There would be effects on biological resources including marbled murrelet, coho salmon, and steelhead, and their associated critical habitat. Wetland and riverine features (including habitat for anadromous fish), forested riparian, and sensitive natural communities would be inundated.	The alternative is ***potentially economically infeasible.*** The alternative is ***potentially financially infeasible.***

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Alternative	Screening Criteria					
	Water Reliability and Sustainability	**Flexibility and Resiliency**	**Schedule and Implementation**	**Water Quality**	**Environmental and Social Stewardship[2]**	**Economic and Financial Feasibility**
Upper Nicasio Reservoir	The alternative can meet the goal of adding substantial local storage. Technical risks are moderate, and the alternative is relatively favorable from a geotechnical standpoint, and from a water reliability and sustainability perspective.	The alternative integrates well with the current operations of Marin Water. It is unlikely that this reservoir could be operated as a self-filling, passive system. However, flexibility could be achieved with pump stations or conveyance systems to utilize the storage capacity. The reservoir could reasonably serve as an endpoint for imported water should the Water Conveyance Improvements Project be implemented.	Constructability is favorable compared to other alternatives: there are no clear obstacles to developing a typical construction schedule. The reservoir would inundate parcels with agricultural land and structures including residences and roads. If this alternative moves forward, measures to reduce inundation or otherwise protect structures would be evaluated.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir. Water quality for downstream releases during construction must be considered.	There would be effects on biological resources including wetlands and riverine features, forested riparian, and sensitive natural communities that would be lost/flooded. Few special-status species have been recorded in the dam/reservoir footprint (historic records of Western bumblebee). No critical habitat is present. The potential to encounter important cultural resources is considered low (there are undocumented buildings, complexes and structures in the area but no recorded archaeological resources).	The alternative is ***potentially economically feasible*** pending exploration of land acquisition. The alternative appears ***potentially financially feasible***, conditional on land acquisition.
Nicasio Spillway Fixed Gates	As a standalone endeavor, the alternative cannot meet the goal of adding substantial local storage. Technical risks are low.	The alternative integrates well with the current operations of Marin Water. Based on the largely passive capture of surface water and large watershed the alternative has flexibility to fit in the range of future scenarios.	Constructability is favorable compared to other alternatives; there are no clear obstacles to developing a typical construction schedule. Marin Water owns the spillway and surrounding area.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir.	Effects on resources (e.g., biological resources) to be evaluated in the future. It is unlikely that this alternative would adversely affect important cultural resources.	The alternative is ***economically feasible***. The alternative is ***financially feasible***.
Soulajule Spillway Moveable Gates	As a standalone endeavor, the alternative cannot meet the goal of adding substantial local storage. Technical risks are low.	The alternative integrates well with the current operations of Marin Water. Based on the largely passive capture of surface water and large watershed this alternative has flexibility to fit in the range of future scenarios. Resilience is relatively low since the need to lower gates ahead of impending storms would likely compromise the value of the alternative and increase its costs.	Constructability is favorable compared to other alternatives; there are no clear obstacles to developing a typical construction schedule. Marin Water owns the spillway and surrounding area.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir.	Effects on resources (e.g., biological resources) should be evaluated in the future if this alternative advances. It is unlikely that this alternative would adversely affect important cultural resources.	The alternative is likely **not economically feasible,** but it is ***financially feasible***.

TABLE 1 – SCREENING OF ALTERNATIVES

Alternative	Screening Criteria					
	Water Reliability and Sustainability	**Flexibility and Resiliency**	**Schedule and Implementation**	**Water Quality**	**Environmental and Social Stewardship[2]**	**Economic and Financial Feasibility**
Kent Spillway Moveable Gates	As a standalone endeavor, the alternative cannot meet the goal of adding substantial local storage. Technical risks are low.	The alternative does integrate well with the current operations of Marin Water. Based on the largely passive capture of surface water and large watershed this alternative has flexibility to fit in the range of future scenarios. Resilience is relatively low since the need to lower gates ahead of impending storms would likely compromise the value of the alternative and increase its costs.	Constructability is favorable compared to other alternatives; there are no clear obstacles to developing a typical construction schedule. Marin Water owns the spillway and surrounding area.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir.	Effects on resources (e.g., biological resources) should be evaluated in the future. It is unlikely that this alternative would adversely affect important cultural resources.	The alternative is likely ***not economically feasible,*** but it is ***financially feasible***.
Alpine Spillway Moveable Gates	As a standalone endeavor, the alternative cannot meet the goal of adding substantial local storage. Technical risks are low.	The alternative integrates well with the current operations of Marin Water. Based on the largely passive capture of surface water this alternative does have flexibility to fit in the range of future scenarios. Resilience is relatively low since the need to lower gates ahead of impending storms would likely compromise the value of the alternative and increase its costs.	Constructability is favorable compared to other alternatives: there are no clear obstacles to developing a typical construction schedule. Marin Water owns the spillway and surrounding area.	There appear to be no major concerns regarding water quality from water captured passively at this reservoir.	Effects on resources (e.g., biological resources) should be evaluated in the future. It is unlikely that this alternative would adversely affect important cultural resources.	The alternative is likely **not economically feasible** but it is **financially feasible**.
Dredging of Nicasio Reservoir	The alternative can meet the goal of adding substantial local storage.	The alternative would ultimately integrate well with the current operations of Marin Water. However, Marin Water could lose the use of the reservoir during the many-year-long dredging operation. Based on the largely passive capture of surface water and large watershed the alternative has flexibility to fit in the range of future scenarios.	There are constructability challenges associated with the years-long, large-scale dredging, dewatering, off-hauling, and disposal of dredged materials. These challenges would greatly affect the project's cost. Marin Water owns Nicasio Reservoir.	Maintaining water quality of released water would require careful management and environmental controls during construction.	Effects on resources (e.g., biological resources) would be evaluated in the future. The alternative would likely adversely affect archaeological and architectural resources and would require detailed study.	The alternative is ***not economically or financially feasible***.

4.0 SUMMARY AND CONCLUSIONS

The results of the alternatives screening indicate that many of the alternatives are infeasible:

- Alpine dam raise is not considered financially or economically feasible because of construction complexity and cost.
- Nicasio dam raise is not considered feasible due to cost and complexity.
- Kent dam raise is technically feasible but has constructability and cost challenges that will require further investigation if this alternative is advanced.
- Devil's Gulch is fatally flawed because it is entirely located on State and Federal Land: Samuel P. Taylor State Park and the Golden Gate National Recreation Area.
- Halleck Reservoir is not economically or financially feasible because of the large size of the embankment required and the resulting construction cost.
- The dredging of Nicasio is not economically or financially feasible because of its construction complexity and extreme cost.
- None of the spillway modifications on its own can satisfy the goal of providing substantial additional local storage on their own. However, the addition of permanent gates at Nicasio Reservoir, although only providing 3,000 acre-feet of additional storage, is economically and financially feasible. Spillway modifications at Nicasio Reservoir could be carried forward as a near-term project because it can be constructed relatively quickly and economically. Implementation of spillway modifications at Nicasio Reservoir could incrementally reduce the capacity needed from another storage project(s).

Thus, it appears that Soulajule dam raise, Kent dam raise, and Upper Nicasio reservoir should move forward to the next phase of the evaluation. Spillway modifications may also be further investigated as potential near-term storage improvements.