Staff Report

TO: Board of Directors

FROM: Doug Roderick, P.E., Director of Engineering

DATE: September 14, 2022

SUBJECT: **Plan for Water – Consulting Contract Amendment – Consent**

ENGINEERING DEPT

RECOMMENDATION:

Approve Task Order #2 in the amount of $228,310 to WEST Consulting Inc. for the development of an HEC-HMS model to support the hydrology development for the Plan for Water and authorize the General Manager to execute the appropriate documents.

BACKGROUND:

The Plan for Water (PFW) is a long-range decision tool to guide NID's water management. The PFW is an open and comprehensive look by NID and the community at the potential limitations of its available water resources and the impacts of new regulations, changes in land use, climate change, and community visions. Part of the PFW process will be to develop a range of potential scenarios for the Board to consider when determining the best ways to meet the community's demand for water for the next 50 years while weighing the impact on NID, the community, and the environment. When complete, the PFW will show how a variety of future water supply and demand scenarios could be integrated to ensure our community enjoys the same high-quality, reliable water system that NID has now.

As part of the technical portion of the PFW process, the Board awarded a consulting contract to WEST Consulting Inc (WEST) in the amount of $1,024,291 during the May 11, 2022 board meeting.

On July 19, 2022, staff met with members of the WEST team to discuss the overall project status and to hear a recommendation from the WEST team to consider the development of an HEC-HMS model to better inform and improve the unimpaired hydrology. The original WEST proposal included utilizing a statistical approach based on historical data to calculate runoff while using Coupled Model

Intercomparison Project Phase 6 (CMIP6) as climate input and developing forecast equations.

WEST has recommended that NID consider developing an HEC-HMS model to support the hydrology development. The primary advantage of using HEC-HMS is that it integrates a physically based model. A physically based model is important because statistically based models may not perform well outside of the analyzed range. Extreme droughts and floods may be outside the hydrological range of the statistical approach, a consequence of climate change. Another advantage would be to utilize it for planning purposes. The HEC-HMS model can serve as a consistent decision-making tool that enhances understanding of basin hydrology including runoff, inflows, and snow conditions. NID would be able to physically simulate hydrology and physically analyze water supply and irrigation strategies, potential environmental impacts, and regulatory compliance options.

Another advantage of developing an HEC-HMS model is that in the future when additional changes/improvement in the CMIP (phase 7, 8, etc) occurs, that information can be integrated into the model. If the statistical approach is used, each time the CMIP is updated, new calculations would need to be performed, essentially requiring a complete redo of the statistical model. Since the PFW is considering a projection of 50 years, and the District is going to be reviewing/updating the model every few years, the overall costs for this upfront work now have value by reducing costs in the future.

After an internal discussion of the WEST proposal, staff sent out the proposal to the stakeholder group to review and provide feedback. The proposal was sent to Melinda Booth of SYRCL, Traci Sheehan of Foothills Water Network, Barbara Bashall of the Nevada County Contractors Association, Chris Shutes of the California Sportfishing Protection Alliance, Beth Lawson of the California Department of Fish and Wildlife, and Joe Fischer of the Placer County Farm Bureau. On August 18, 2022, staff and stakeholders met to discuss the merits of WEST's recommendation to develop the HEC-HMS. Based on that discussion, it was agreed to forward this recommendation to the Board for consideration.

At the September 13, 2022, Plan for Water meeting, members of the WEST team presented this item to the Board and the public to respond to questions. No Board action was taken at this meeting.

As discussed at the May 11, 2022, board meeting, staff identified that only $450,000 was currently available in the 2022 budget and since the scope of work will occur in both 2022 and 2023, recommended waiting until later in the year to determine if an amendment of the 2022 budget would be necessary. Based on estimated contract spending thru the end of the year, including this additional scope of work, a budget amendment is still not necessary. The remaining contract costs will be included in the upcoming 2023 budget.

It is recommended that the Board approve Task Order #2 in the amount of $228,310.

BUDGETARY IMPACT: Overall contract including Task Order #2 would be $1,252,601. The remaining $802,601 would be included in the proposed 2023 budget.

ATTACHMENTS (1)

- WEST Consultants Inc. Proposal

DR

NEVADA IRRIGATION DISTRICT

PLAN FOR WATER
HYDROLOGY PLANNING

July 27, 2022

Prepared by:

WEST Consultants, Inc.
101 Parkshore Drive
Folsom, CA 95630-4726

WEST Consultants, Inc.

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1. July 19, 2022 Meeting Minutes

On July 19, 2022, at the request of Mr. Doug Roderick, P.E., a meeting was held for the purpose of coordinating a plan for the development of the hydrology for the Plan for Water project for Nevada Irrigation District (NID). Attending the meeting were Doug Roderick, Engineering Manager, NID and for WEST Consultants were David Curtis, Sr. Vice President, Marco Bell, Senior Project Manager, Luciana Kindl Da Cunha, Sr. Project Manager/Climate Change Hydrologist, Cailleen Yu, Staff Engineer, and Matt Riddlebarger, Staff Engineer. Subconsultants attending virtually were Jeff Meyer, Principal, Jared Emery, Senior Water Resources Engineer, Katherine Klug, Associate Engineer, and Megan Lionberger, Senior Water Resources Engineer.

The focus of the meeting was on two scope items. First on update historical watershed runoff to include the most recent data available since the current historical data is only through the year 2011. Second to update/revise projected climate change conditions based on Consultant's recommendation and input from stakeholders and the Board.

Doug then described the watershed and how the hydrology works in the NID basin and area of interest. Then the HEC-ResSim model structure was briefly discussed.

The data for updating the hydrology will come from the existing model, NID data, PG&E data, Place County Water Agency and other third parties that may have data available.

Luciana then discussed climate projections including the pros and cons of using CMIP6 v CMIP5. CMIP5 is the Couple Model Intercomparison Project Phase 5. It has data available but was developed in 2013 and is a bit outmoded today. CMIP6, Couple Model Intercomparison Project Phase 6 is from 2021 but has limited availability and does not have runoff data for use in the hydrology modeling for NID. CMIP6 data also shows increased temperature ranges which has an impact on snowpack and snowmelt functions and timing.

WEST recommended three hydrologic alternatives for consideration.

1) **CMIP5 Alternative** - Evaluate differences between CMIP5 and CMIP6 and if not too different, use CMIP5. We expect there to be differences due to the new temperature regime in CMIP6.
2) **CMIP6 Alternative** - Build an HEC-HMS Model and use CMIP6 data to simulate runoff using a physically based model.
3) **Statistical Approach** - Calculate runoff based on statistical approaches using CMIP6 as input and develop forecast equations to estimate runoff.

The details of the three approaches are further discussed in the next section. Meeting was adjourned at 4:30 PM.

2. Unimpaired Hydrology Options

CMIP5 Alternative

This approach evaluates if the differences between CMIP5 and CMIP6 are not significant. If the two data sets are not too different, we can simply use CMIP5. This approach would be the most economical since the data is readily available, including runoff. However, we expect there to be differences due to the new warmer temperature regime of CMIP6 that may have a significant impact on snowpack and snowmelt.

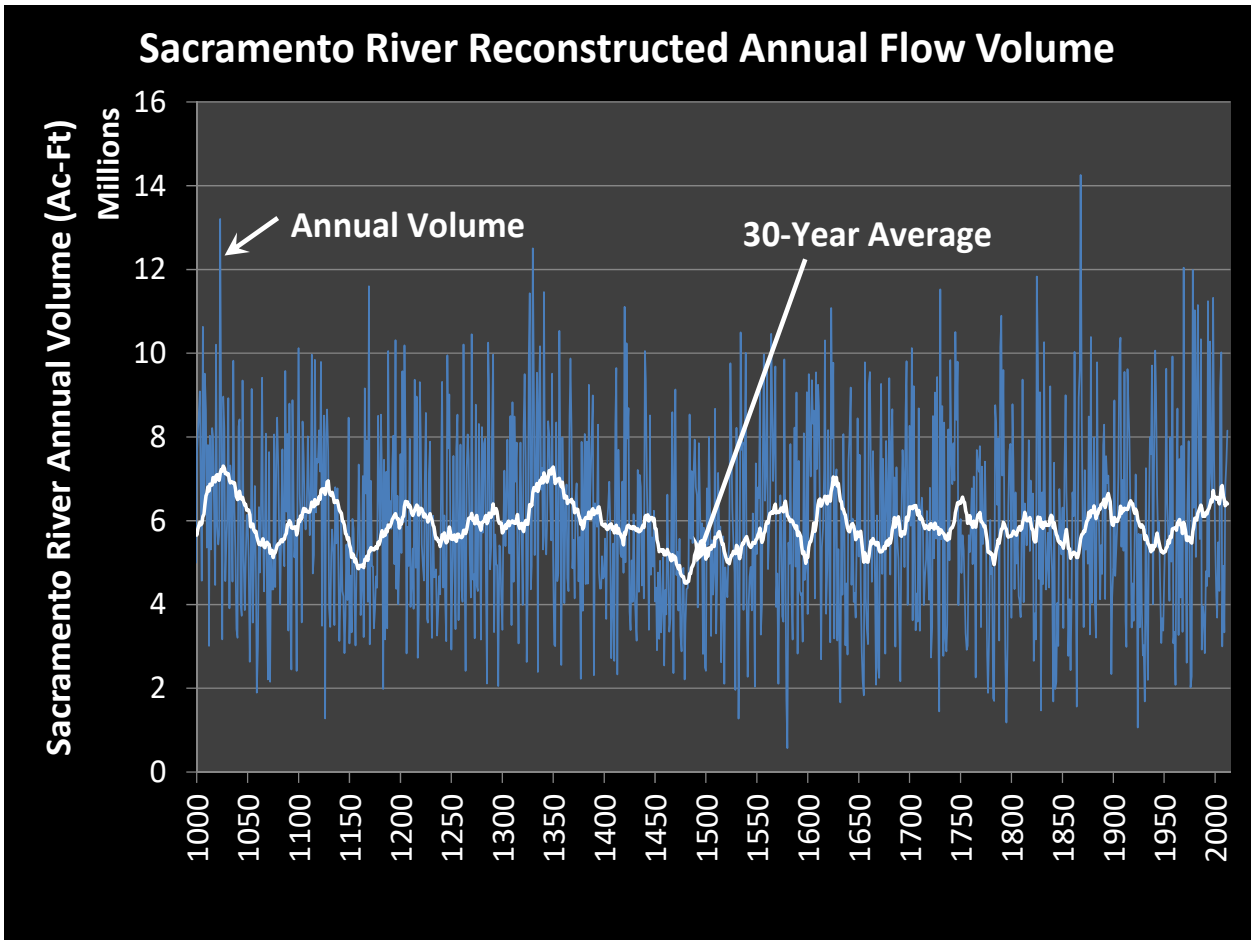
CMIP6 Alternative

This is the preferred technical approach. WEST would build an HEC-HMS Model and use CMIP6 data to simulate runoff using a physically based model. This alternative is the most technically defendable and potentially the most beneficial to NID, but also has the highest cost.

The CMIP6 alterative include HEC-HMS model development, computing the climate change runoff, checking the results, and integrating with HEC-ResSim. The details of the proposed scope and cost are included as Attachment A. After analyzing the details of the level of effort and cost, the estimated amount is approximately $230k to perform this alternative.

The current unimpaired inflows are based on statistical analysis of historical data. Statistical approaches to climate change planning have failed in the past. The primary advantage of using HEC-HMS is that it integrates a physically based model with the latest climate change model results. A physically based model is important because statistically based model may not perform well outside of the analyzed range; for example, extreme floods and droughts may be outside the hydrological range that the statistical approach would be applicable, a consequence of climate change. As an example, Agencies did not properly predict runoff conditions in 2021 water year due to statistical models not simulating extreme conditions properly. Physically based models are more apt to perform better under extreme conditions such as those forecasted to occur under climate change conditions. HEC-HMS is a useful tool for simulation specific drought conditions and future climate change conditions. HEC-HMS will nicely support the HEC-ResSIM modeling efforts. A physically based hydrologic model would result in simulation scenarios that are closer to the truth than scenarios based on statistically inflow computations; thus, increasing the District and stakeholder confidence in the process.

Other advantages include model availability for planning purposes; NID would be able to physically simulate hydrology and physically analyze water supply and irrigation strategies, potential environmental impacts, and regulatory compliance options. The HMS model can serve as a consistent decision-making tool that enhances understanding of basin hydrologic including runoff, inflows, and snow conditions.



Observed and paleo data showed that NID needs to plan for a much wider range of potential water availability than was previously considered. Further, the same data showed how rapidly conditions can change between persistently wet and persistently dry conditions. These changes can occur within the time scale of NID's planning horizon. HEC-HMS does a nice job at analyzing how climate change impacts this historically occurring signal and can more accurately simulate the bookend scenarios.

Adequately simulating the bookend scenarios is significant to NID because if we do not identify these impacts correctly, we may not implement a most advantageous strategic alternative. With HEC-HMS we can simulate the reservoir inflows more accurately than a statistical based approach and we can also simulate the local inflows more precisely. Developing a suite of effective strategies of the Plan for Water will be dependent on the proper simulation of the climate change hydrology which can best be simulated using HEC-HMS with the current CMIP6 data set.

Statistical Approach

The Statistical Approach would involve calculating runoff based on statistical approaches using CMIP6 as input and develop forecast equations to estimate runoff. A multi variate function would be developed based on historical data. Significant parameter can be identified that account for the runoff experienced. Then the function can be used to forecast inflows from CMIP6 inflows. The advantages of this approach are that is technically simple and that it uses the latest CMIP6 data set as inputs. We are currently planning on using this approach and the costs are included in the current contract.

3. Data Request

The WEST Team is requesting the following information from NID to perform some of the hydrologic and HEC-ResSim development tasks:

- 'Calculation of unimpaired hydrology' files from HDR's 2020 PFW work
- ResSim Modeling files from HDR's 2020 PFW work
- Associated Red-Blue Model spreadsheet that calculates the sharing of water between PG&E and NID
- The new long-term water purchase agreement with PG&E (we have a copy labeled 8/8/18 NID Board Review – It may be the final version, but want to be sure)
- Available gage data, discharge flow history and historical demands
- Maps or GIS files of gage locations, basin delineations and infrastructure such as reservoirs and tunnels
- Available GIS linework of canals

We also request a meeting with the Operations Manager to review the operational scenarios that NID implement during floods high water events, droughts conditions, and operations of irrigation deliveries.

4. Meeting Presentation

The next three pages include slides from the July 19, 2020, hydrology meeting.

WEST CONSULTANTS
WATER | ENVIRONMENTAL | SEDIMENTATION | TECHNOLOGY

Item 5:
Unimpaired Hydrology

July 19, 2022

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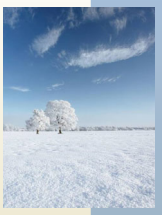
AGENDA



- Scope & Watersheds
- Existing Hydrology
- CMIP5
- CMIP6
- Recommendations

2

Scope

Update historical watershed runoff to include the most recent data available (the current historical data is only through the year 2011)

Update/revise projected climate change conditions based on Consultant's recommendation and input from stakeholders and the Board

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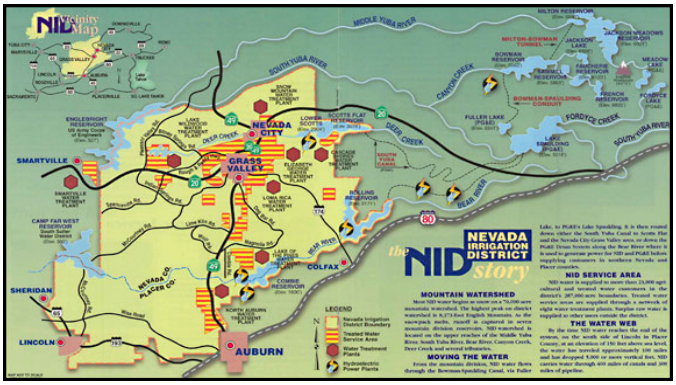

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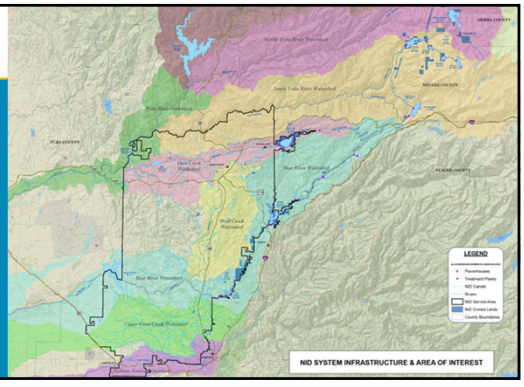
Basin Watersheds



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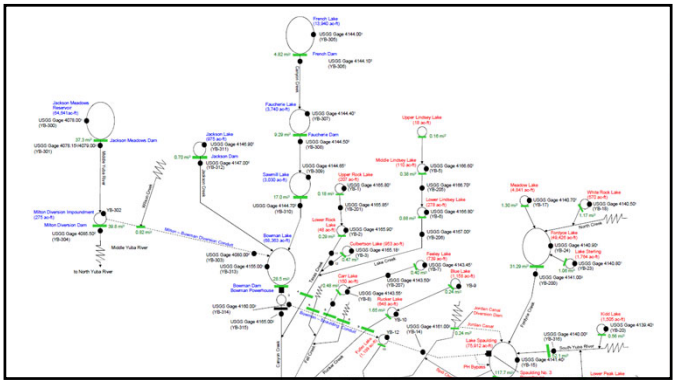

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Existing Hydrology

- Existing Model
- NID Data
- Third Party Sources

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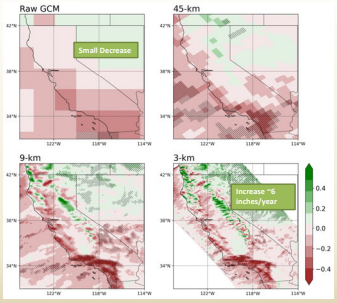

Future (2080-2100 average) minus historical (1980-2015 average) simulated precipitation anomalies [mm/d]. Source: CMIP6 Downscaling Using WRF | Alex Hall's Research Group [ucla.edu]

Climate Projections

Global Climate Models	CMIP5 (2016,	CMIP6 (2021,
Downscale Meteo variables	Available multiple methods	Limited availability
Surface processes and routing	VIC provided by California Water Commission (2016)	Unavailable
RUNOFF		

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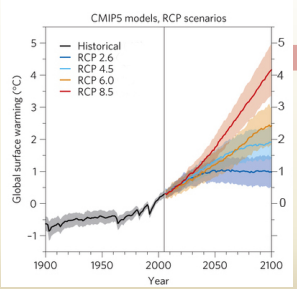

CMIP5 Coupled Model Intercomparison Project Phase 5

https://pcmdi.llnl.gov/about.html
https://pcmdi.llnl.gov/mips/cmip5/
https://esgf-node.llnl.gov/projects/cmip5/

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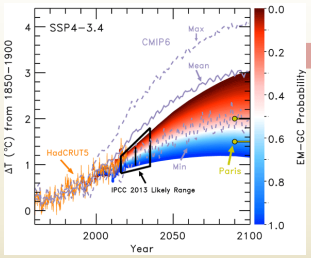

CMIP6 Coupled Model Intercomparison Project Phase 6

https://pcmdi.llnl.gov/CMIP6/
https://www.wcrp-climate.org/wgcm-cmip/wgcm-cmip6
CMIP6 Downscaling Using WRF | Alex Hall's Research Group (ucla.edu)

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Recommend Alternatives

1) Evaluate differences between CMIP5 and CMIP6 – if not too different, use CMIP5
2) Build an HEC-HMS Model and use CMIP6
3) Calculate runoff based on statistical approaches

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DISCUSSION

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ATTACHMENT A – HMS Scope and Costs

Proposal

CMIP6 Alternative

NEVADA IRRIGATION DISTRICT

Scope of Work & Cost

7/27/2022

Prepared For:

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1036 West Main Street
Grass Valley, CA 95945

Prepared By:

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Contents

Overview

WEST proposes the development a HEC-HMS model to support the hydrology development for the Nevada Irrigation District (NID) Plan for Water. The hydrologic model will be used to generate the unimpaired hydrology inflows for climate change analysis and for simulating planning scenarios for the Strategy Alternatives Analysis. Observed and paleo data showed that NID needs to plan for a much wider range of potential water availability than was previously considered. Further, the same data showed how rapidly conditions can change between persistently wet and persistently dry conditions. These changes can occur within the time scale of NID's 50-year planning horizon. HEC-HMS does a nice job at analyzing how climate change impacts this historically occurring signal and can more accurately simulate the bookend scenarios.

Task Description

1. Data Collection

WEST will perform data collection of stream, reservoir, diversion, and elevation data to support the model development. The previous HEC-ResSim study identified many project gages which will aid the data collection effort. Gage data will be used to perform model calibration and validation. Elevation data will be collected to develop the model terrain. The National Elevation Dataset from the U.S. Geological Survey has 10-meter resolution elevation data available in the watershed.

2. Gridded Data Collection and Manipulation

WEST will collect precipitation, temperature, and snow water equivalent (SWE) data for 3-4 years. Daily precipitation and temperature data are available from Parameter-elevation Regressions on Independent Slopes Model (PRISM). Hourly data prior to 1981 are available from National Climatic Data Center. SWE data are available from the National Operational Hydrologic Remote Sensing Center Snow Data Assimilation System. WEST will perform downscaling and reprojection of gridded observed data.

3. Terrain Development

Modeler will perform watershed delineation and terrain development. Subbasins will be delineated at all gage and reservoir locations. Junctions will be placed at gage locations to allow comparison of model data to observed data. The terrain will be reviewed and modified to ensure developed areas reflect current drainage and snowmelt hydrology.

4. Snowmelt Runoff Model Calibration

WEST will identify three or four historical snowmelt years to calibrate snowmelt meteorologic model parameters. WEST will select historical snowmelt years with significant peak snowpack, late season melt, and years with combined rainfall and snowmelt runoff. Modeler will compare computed runoff and reservoir elevations to observed data and adjust snowmelt parameters to achieve calibration.

5. HMS Model Development

Modeler will develop the hydrologic model using HEC-HMS. Model elements will correspond to the HEC-ResSim nodes representing gages, reservoirs, diversions, and inflows.

6. Calibration

The model will be calibrated using at least two years of observed data. Basin parameters such as transform, routing, loss, and baseflow will be adjusted to calibrate to historic runoff events. WEST will calibrate with consideration to water balance variables including total annual runoff, evapotranspiration, etc.

7. Validation

The model will be validated using at least one year of observed data. The modeler will adjust basin parameters including baseflow, deficit constant loss rates, routing, and unit hydrograph parameters as necessary.

8. Model Review

Following our QA/QC process, the model will be independently reviewed by an expert member of the WEST team that was not involved in the development process. The model will then be modify to meet the expert's review comments.

9. Download Global Climate Model Downscaled Datasets

CMIP6 data will be downloaded and data will be reviewed for technical consistency.

10. Regrid and reformat precipitation and temperature data

Precipitation and temperature data will be re-projected and formatted to match HMS grid model, including all historical and climate change projections.

11. Run HMS for all models/scenarios

Execution of all scenarios with the HMS physically based model to develop runoff and local inflows.

12. Plot and evaluate the results

Analyses will be performed to ensure the results are technically consistent.

13. Memorandum with findings

A technical memorandum will be completed to document the methodology and findings.

14. Coupling with HEC-ResSim

The model will need to be coupled with HEC-ResSim. This task is for the subconsultant Western Hydrologics portion of the work.

Cost Estimate

A spreadsheet of the proposed cost estimate follows.

CMIP6 Alternative - WEST Cost Estimate		Principal	Project Manager	Hydrologist Scientist	Senior Engineer	Staff Engineer	GIS Specialist	Technical Writer	Administrative Assistant	WHC Senior Water Resources Engineer	Total Labor
Task Item	**Description**	**$ 301.00**	**$ 250.00**	**$ 172.00**	**$ 171.00**	**$ 133.00**	**$ 172.00**	**$ 125.00**	**$ 97.00**	**$ 180.00**	
1	Data Collection		16			64					$ 12,512.00
2	Gridded data collection and manipulation		8			120	40				$ 24,840.00
3	Terrain Development		8			16	48				$ 12,384.00
4	Snowmelt Runoff Model Calibration		8			120					$ 17,960.00
5	HMS model development		8			120					$ 17,960.00
6	Calibration		16	16		300					$ 46,652.00
7	Validation		8	8		120					$ 19,336.00
8	Model Review	8	16	40							$ 13,288.00
9	Download Global Climate Model Downscaled Datasets		4	2		40					$ 6,664.00
10	Regrid and reformat precipitation and temperature data		4	2		32					$ 5,600.00
11	Run HMS for all models/scenarios		4	4		80					$ 12,328.00
12	Plot and evaluate the results		8	12		96					$ 16,832.00
13	Memorandum with findings		4	6		80			16		$ 14,224.00
14	Coupling with HEC-ResSim		4			10				30	$ 7,730.00
										Total Proposed Fee	**$ 228,310.00**